

RAC2

EPA Region 2

Quality Assurance Project Plan

**Maunabo Groundwater Contamination Site
Remedial Investigation/Feasibility Study
Maunabo, Puerto Rico**

**EPA Contract No. EP-W-09-002
WA 014-RICO-02XF**

January 28, 2010

REMEDIAL ACTION CONTRACT
FOR REMEDIAL RESPONSE, ENFORCEMENT OVERSIGHT,
CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR
THREATENED RELEASE OF HAZARDOUS SUBSTANCES
IN EPA REGION 2

FINAL QUALITY ASSURANCE PROJECT PLAN

MAUNABO GROUNDWATER CONTAMINATION SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
MAUNABO, PUERTO RICO
Work Assignment No. 014-RICO-02XF

U.S. EPA CONTRACT NO. EP-W-09-002
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Acronyms

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1-6	Water Level Measurement
1-8	VOC Air Sampling Using WSEPA Method TO-15 With SUMMA® Canister
1-9	Tap Water Sampling*
1-10	Field Measurement of Organic Vapors
1-11	Sediment/Sludge Sampling*
2-1	Packaging and Shipping of Environmental Samples*
2-2	Guide to Handling of Investigation Derived Waste
3-1	Geoprobe® Sampling
3-2	Topographic Survey
3-4	Geophysical Logging, Calibration, and Quality Control
3-5	Lithologic Logging
3-6	Underground Facility Location
4-1	Field Logbook Content and Control*
4-2	Photographic Documentation of Field Activities
4-3	Well Development and Purging*
4-4	Design and Installation of Monitoring Wells in Aquifers*
4-5	Field Equipment Decontamination at Nonradioactive Sites*
4-6	Hydraulic Conductivity Testing
4-8	Environmental Data Management
5-1	Control of Measurement and Test Equipment *
PSOP-1	Passive Diffusion Bag Water Sampling
*	Includes RAC II Contract-Specific Clarification

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Appendix D	CDM DV SOP 029A, Revision 0
Appendix E	Data Management
Appendix F	Field Forms
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QAPP Worksheet #1
Title and Approval Page

FINAL QUALITY ASSURANCE PROJECT PLAN (QAPP)
for
Maunabo Groundwater Contamination Site
Remedial Investigation/Feasibility Study
Maunabo, Puerto Rico

US Environmental Protection Agency (EPA) Region II

Prepared by: CDM Federal Programs Corporation (CDM)
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(212) 785-9123

Date: January 28, 2010

CDM Project Manager:
Michael Valentino

Signature: 

CDM Project QA Officer:
Doug Updike

Signature: 

EPA Project Manager:
Luis Santos

Signature: _____

CDM RAC II Technical Operations Manager:
Jeanne Litwin

Signature: 

EPA Region II Hazardous Waste Support Section:
Linda Mauel

Signature: _____

Document Control Number: 3320-014-00276

CDM

Final Quality Assurance Project Plan

R2-0000182

QAPP Worksheet #2

QAPP Identifying Information

Site Name/Project: Maunabo Groundwater Contamination Site Remedial Investigation/Feasibility Study (RI/FS)

Site Location: Maunabo, Puerto Rico

Operable Unit: Not Applicable (N/A)

Contractor Name: CDM

Contract Title: Remedial Action Contract
Region 2/No. EP-W-09-002

Work Assignment Number: 014-RICO-02XF

Guidance Used to Prepare QAPP:

EPA Requirements for QAPPs for Environmental Data Operation QA/R5, EPA Guidance for QAPPs, QA/G5, Uniform Federal Policy for QAPPs Manual.

Regulatory program: Superfund

Approval entity: EPA Region 2

Is QAPP generic or project-specific: Project Specific QAPP

Dates of Scoping Sessions: December 7, 2006

Dates and titles of QAPP documents written for previous site work: None

Organizational Partners (Stakeholders) and Connection with Lead Organization:
PREQB (Puerto Rico Environmental Quality Board)

Date Users:

CDM, EPA Region 2, PREQB

Required QAPP elements and required information that are not applicable to the project, explanation for their exclusion:

None

QAPP Worksheet #2
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet #/ Crosswalk to Required Documents
2.1 Title and Approval Page	- Title and Approval Page	1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	- Table of Contents - QAPP Identifying Information	2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	- Distribution List - Project Personnel Sign-Off Sheet	3 4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table	5 6 7 8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)	9 10
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Site-Specific PQOs - Measurement Performance Criteria Table	11 12

QAPP Worksheet #2
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet #/ Crosswalk to Required Documents
	<ul style="list-style-type: none"> - Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table 	13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	<ul style="list-style-type: none"> - Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/ Timeline Table 	14 15 16 Figure 4
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	<ul style="list-style-type: none"> - Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/ SOP Requirements Table - Analytical Methods/SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table 	17 18 19/Figures 2, 5-7 20 21/Table 2 22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	<ul style="list-style-type: none"> - Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table 	23 24 25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures	<ul style="list-style-type: none"> - Sample Collection Documentation Handling, Tracking, and Custody SOPs 	26

QAPP Worksheet #2
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet #/ Crosswalk to Required Documents
3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	- Sample Container Identification - Sample Handling Flow Diagram - Example Chain-of-Custody Form and Seal	27 NA
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree	28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs	29 30
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4.3 Final Project Report	- Final Report(s)	33
5.1 Overview		NA
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment	- Verification (Step I) Process Table - Validation (Steps IIa and IIb) Process Table - Validation (Steps IIa and IIb) Summary Table - Usability Assessment	34 35 36 37 37

QAPP Worksheet #2
QAPP Identifying Information

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	QAPP Worksheet #/ Crosswalk to Required Documents
5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities		
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining		None Streamlining of Data Validation will not be performed

**QAPP Worksheet #3
Distribution List**

QAPP Recipients/Document Control Number	Title	Organization	Telephone Number	Fax Number	E-mail Address
Fernando Rosado	Regional Project Officer	EPA	(212) 637-4346	(212) 637-3966	rosado.fernando@epa.gov
Carlos O'Neill	Remedial Project Manager	EPA	(787) 977-5821	(787) 289-7104	oneill.carlos@epa.gov
Linda Mauel	Hazardous Waste Support Section Chief	EPA	(732) 321-6766	(732) 321-4381	mauel.linda@epa.gov
William Sy or designee	EPA QA Officer	EPA	(732)-632-4766	(732) 321-4381	sy.william@epa.gov
Diana Cutt	Hydrogeologist	EPA	(212) 637-4311	(212) 637-4360	cutt.diana@epa.gov
Chloe Metz	Human Health Risk Assessor	EPA	(212) 637-4449	(212) 637-4360	metz.chloe@epa.gov
Chuck Nace	Ecological Risk Assessor	EPA	(212) 637-4164	(212) 637-4360	nace.charles@epa.gov
Pascual Velazquez	Regional Project Manager	PREQB	(787) 767-8181	(787) 620-9536	pascualvelazquez@jca.gobierno.pr
Michael Valentino	Site Manager	CDM	(787) 722-5406	(787) 722-6607	valentinom@cdm.com
Jeanne Litwin	Program Manager	CDM	(212) 785-9123	(212) 785-6114	litwinj@cdm.com
Jeniffer Oxford	Regional QA Coordinator/Project QA Officer	CDM	(212) 785-9123	(212) 785-6114	oxfordjm@cdm.com
Brendan MacDonald	RI Task Leader	CDM	(787) 722-5410	(787) 722-6607	macdonaldbc@cdm.com
Jose Reyes	Field Team Leader	CDM	(787) 722-5409	(787) 722-6607	pinoljr@cdm.com

**QAPP Worksheet #4
Project Personnel Sign-Off Sheet**

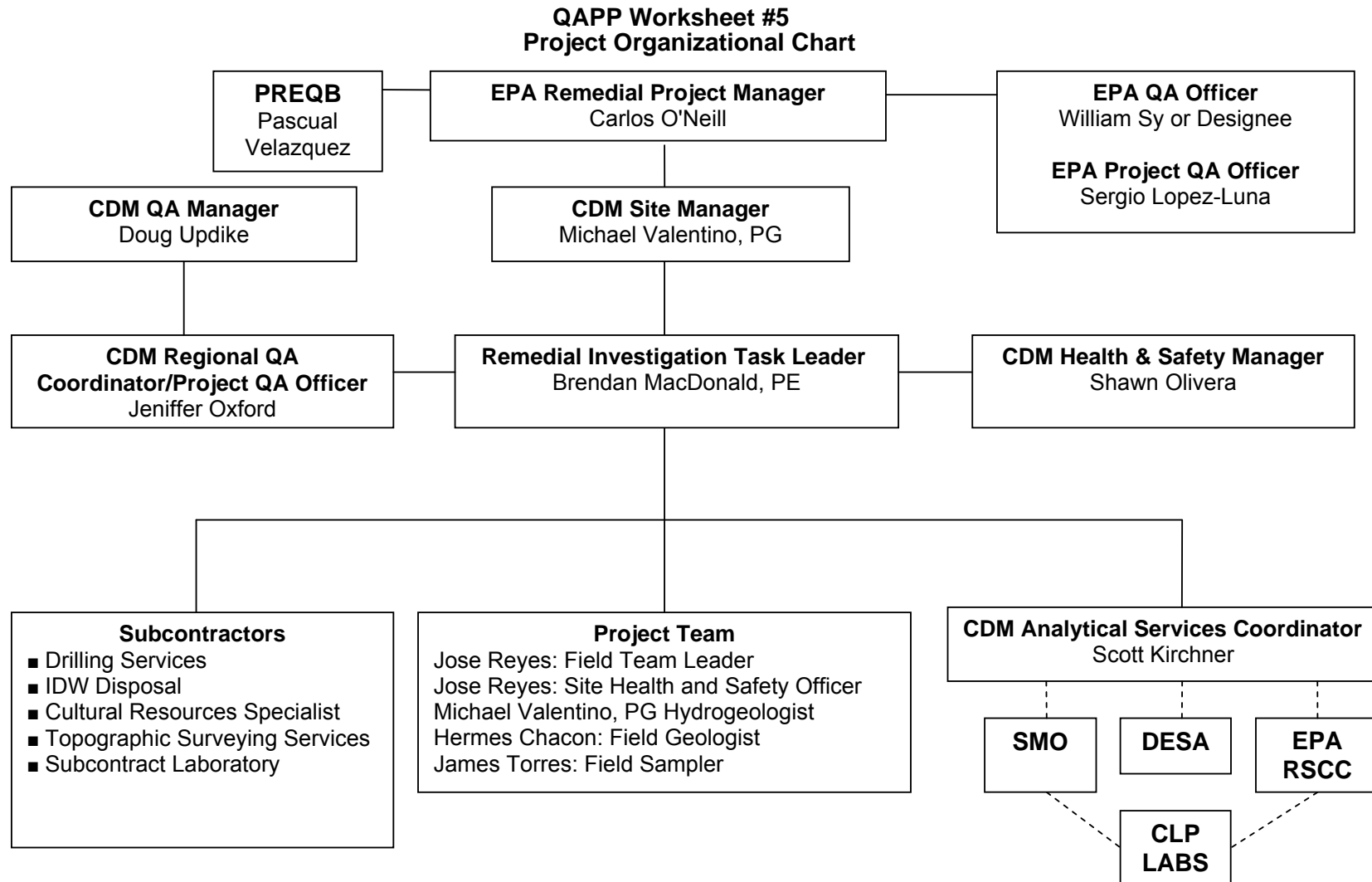
Organization: CDM

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Michael Valentino	Site Manager/Hydrogeologist	(787) 722-5406		
Brendan MacDonald	RI Task Leader	(787) 722-5410		
Jose Reyes	Field Team Leader	(787) 722-5409		
Hermes Chacon	Field Geologist	(787) 278-0563		
James Torres	Field Sampler	(787) 278-0563		

**QAPP Worksheet #4
Project Personnel Sign-Off Sheet**

Organization: EPA

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read
Carlos O'Neill	Remedial Project Manager	(787)977-5821		
Linda Mauel	Hazardous Waste Support Section Chief	(732) 321-6766		
William Sy or designee	EPA QA Officer	(732)-632-4766		
Diana Cutt	Hydrogeologist	(212) 637-4311		



QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
Point of Contact with EPA RPM	CDM Site Manager (SM)	Michael Valentino	(787) 722-5406	All information about the project will be sent to EPA RPM by the SM. Field changes will be discussed with the EPA Remedial Project Manager (RPM) prior to implementation.
Point of Contact with PREQB	EPA Remedial Project Manager (RPM)	Carlos O'Neill	(787) 977-5821	All information about the project will be sent to PREQB RPM by the EPA RPM. Field changes will be informed to the PREQB RPM by the EPA RPM.
Manage Remedial Investigation Tasks	CDM RI Task Leader (RITM)	Brendan MacDonald	(787) 722-5410	Act as liaison to SM concerning RI activities. Daily communication with project team and SM. Communicate implementation issues to Field Team Leader
QAPP changes in the field	FTL	Jose Reyes	(787) 722-5409	Notify RITM immediately and complete a Field Change Request (FCR) form and/or corrected worksheets. Distribute FCR forms to distribution list (Worksheet #3).
	CDM RITM	Brendan MacDonald	(787) 722-5410	Notify EPA RPM, CDM SM and Analytical Services Coordinator (ASC) of delays or changes to field work.
	EPA RPM	Carlos O'Neill	(787) 977 -5821	EPA RPM will notify PREQB RPM of delays or changes to field work.
Completion of daily summary reports	FTL	Jose Reyes	(787) 722-5409	Complete on a daily basis and submit to SM and RITM. SM will forward to EPA RPM upon request.
Field corrective action	CDM RQAC, auditor, RITM, FTL, and field team	Jose Reyes	(787) 722-5409	SM, RITM, FTL, Regional Quality Assurance Coordinator (RQAC) or auditor determines the need for corrective actions. Corrective actions may also be identified by the field team. FTL initiates corrective action on identified field issues immediately or within RQAC recommended timeframe.
Booking of analytical	FTL	Jose Reyes	(787) 722-5409	Submit request to ASC before the timeframe below

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
services	Analytical Services Coordinator	Scott Kirchner	(732) 225-7000	Book Division of Environmental Science and Assessment (DESA) and Contract Laboratory Program (CLP) analytical services 3 weeks ahead of sampling.
Notification of analytical issues	Analytical Services Coordinator	Scott Kirchner	(732) 225-7000	Notify FTL of any sample collection/ shipment issues. Notify Regional Sample Control Center (RSCC), DESA laboratory or subcontract laboratory to initiate corrective action.
	RSCC	Adly Michael	(732) 906-6161	Notify ASC or CLP coordinator of sample shipment or laboratory issues.
Facilitate Database setup and data management planning	Field Team Leader (FTL)	Jose Reyes	(787) 722-5409	Provide sample location, sample ID, and analysis information prior to sample collection. Provide information on sample and analytical reporting groups; and types of report tables required for project.
Analytical services support	ASC	Scott Kirchner	(732) 225-7000	Act as liaison with RSCC for CLP laboratories, with John Birri for DESA and with subcontract laboratory(ies).
Facilitate data management	FTL	Jose Reyes	(787) 722-5409	Provide electronic survey data. Transmit sample tracking information to data manager by the completion of each sampling case.
Reporting of issues relating to analytical data quality including ability to meet reporting limits, and usability of data	Laboratory QA Coordinator or Laboratory Project Manager	TBD	TBD	Communicate to SM or Scott Kirchner (ASC) as appropriate.
	Data Assessor	Scott Kirchner	(732) 225-7000	Communicate to SM or ASC as appropriate. Document situation and effect in a data quality report prepared prior to evaluation of data/technical memoranda/RI report.

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure
QAPP amendments	EPA RPM	Carlos O'Neill	(787) 977-5821	Must approve QAPP and any amendments to the QAPP before they are implemented. Inform PREQB of any amendments to the QAPP.
	SM	Michael Valentino	(787) 722-5406	Initiate QAPP amendments in consultation with EPA RPM. Submit QAPPs prior to field work. Document approvals and informs FTL and RQAC of approvals.
Safety decisions; reporting of safety issues; tailgate safety meetings	Health and Safety Officer	Jose Reyes	(787) 722-5409	Implement Health and Safety Plan (HSP) recommended changes due to changes in field conditions in conjunction with CDM's Health and Safety Manager, Shawn Oliveira. Inform RITM and SM of any changes. Hold daily safety briefings.

QAPP Worksheet #7
Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Michael Valentino	SM	CDM	Oversees project and responds to EPA RPM. Manages subcontractors.	B.S. Geology; M.S. Hydrogeology; P.G. 21 years experience in hydrogeological and geological investigations.
Brendan MacDonald	RITM, FS Task Manager (FSTM)	CDM	Oversees RI and FS tasks and responds to SM	B.S., Materials Engineering; M.S. Engineering Management, P.E., BCEE; LEED® AP; 19 years experience in environmental engineering
Joe Mayo	Project Senior Scientist	CDM	Develop technical approach and provide guidance during the execution of field activities	B.A. Biology (Minor – Chemistry); M.S., Environmental Science; 19 Years Experience in Environmental Investigations, 11 Years of PM experience.
Michael Valentino	Project Hydrogeologist	CDM	Provide guidance on the drilling program and analyze the geologic data for the RI and FS Reports	B.S. Geology; M.S. Hydrogeology P.G. 21 years experience in hydrogeological and geological investigations.
Jeniffer Oxford	Regional QA Coordinator/ Project QA Officer	CDM	Oversees adherence to QA requirements	B.S., Natural Sciences; 8 years experience in analytical chemistry; 20 years experience in environmental science; CHMM.
Shawn Olivera	Health and Safety Manager	CDM	Oversees adherence to Health and Safety requirements	B.S. Chemistry; M.S. Environmental Engineering; Certified Safety Professional (#18988); Certified Industrial Hygienist from the American Board of Industrial Hygiene.
Scott Kirchner	ASC	CDM	Communicate with EPA RSCC, DESA laboratory and subcontract laboratories; manage data tracking, validation and data packages	B.S. Chemistry, Environmental Science Certified Hazardous Materials Manager (CHMM), 19 years experience.

**QAPP Worksheet #7
Personnel Responsibilities and Qualifications Table**

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Melinda Olsen	Data Manager	CDM	Assist in database management, data tracking and field coordination	Associates Degree; 15 years experience in data management.
Nai-chia Luke	Risk Assessor	CDM	Perform human health and ecological risk assessments	M.S., PhD, Plant Physiology, 34 years experience.
Jose Reyes	Field Team Leader	CDM	Oversees all field investigation activities	Associate Degree in Civil engineering and Surveying. 17 years field experience.
Hermes Chacon	Field Geologist 1	CDM Subcontractor	Performs field investigations	B.S. Geology, 17 years of environmental experience
Pat Connelly	Field Geologist 2	CDM	Performs field investigations	B.S. Geology; 2 years field experience.
James Torres	Field Sampler	CDM Subcontractor	Performs field investigations	High School Diploma, 7 years of field experience.

Resumes are kept on file and maintained by CDM.

**QAPP Worksheet #8
Special Personnel Training Requirements Table**

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certifications
All Field Activities	40-hour Occupational Safety and Health Administration (OSHA) Training and Annual 8 hour refresher	40 hour - EPA or vendor; 8-hour web-based or CDM training and on-site safety briefings	various	All field team members	CDM staff, subcontractors	CDM Health and Safety (H&S) database and on site
All Field Activities	Site Supervisor Training	CDM H&S Manager	various	FTL, site H&S officer	FTL, site H&S officer	CDM H&S database and on site
Sample Collection	Trained in EPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) QA sampling methods, Multiport well installation and sampling procedures Field testing procedures	On-site training	various	CDM staff (Field samplers and geologists)	FTL, Geologists, scientists	CDM
Sample Analysis	Trained in EPA analytical methods	Laboratory on-site and vendor training	various	Subcontract laboratory personnel - TBD	Laboratory personnel	Laboratory
Data Validation	Data validation non-Routine Analytical Services (RAS) and non-RAS data	EPA and on-site	various	Data validators	Data Validators (EPA, DESA and/or CDM)	EPA and CDM

**QAPP Worksheet #8
Special Personnel Training Requirements Table**

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certifications
Data Review/ Assessment	None, performed by experienced chemists	CDM	various	CDM chemists	All personnel used for project data review	CDM
QA Audits	EPA G-7 auditor training	CDM	various	CDM auditors	Jeniffer Oxford, RQAC and/or designee	CDM
Self Assessments (SA)	SA training	CDM QACs	various	project personnel	All project staff	CDM

Other tasks requiring specialized skills and training will be performed by appropriately qualified subcontractors, such as: drilling, surveying, well installation and aquatic surveyors. Training, certification and permit requirements will be outlined in separate scopes of work for each task.

QAPP Worksheet #9 Project Scoping Session Participants Sheet

Projected Date(s) of Sampling: Summer - Fall 2007 Project Manager: Michael Valentino			Site Name: Maunabo Goundwater Contamination Site RI/FS Site Site Location: Maunabo, Puerto Rico	
Date of Session: December 7, 2006			Scoping Session Purpose: Technical Scoping Meeting	
Name	Affiliation	Phone Number	E-mail Address	Project Role
Carlos O'Neill	EPA	(787) 977-5821	oneill.carlos@epa.gov	Remedial Project Manager (RPM)
Fernando Rosado	EPA	(212) 637-4346	rosado.fernando@epa.gov	Project Officer (PO)
Diana Cutt	EPA	(212) 637-4311	cutt.diana@epa.gov	Hydrogeologist
Charles Nace	EPA	(212) 637-4164	nace.charles@epa.gov	Risk Assessor
William Sy	EPA	(732) 632-4766	sy.william@epa.gov	EPA QA Officer
Chloe Metz	EPA	(212) 637-4449	metz.chloe@epa.gov	Risk Assessor
Jeanne Litwin	CDM	(212) 785-9123	litwinj@cdm.com	Program Manager
Michael Valentino	CDM	(787) 722-5406	valentinom@cdm.com	Site Manager (SM)
Nancy Rodriguez	CDM (no longer with CDM)			RITM
Joe Mayo	CDM	(212) 785-9123	mayojj@cdm.com	Senior Scientist
Nai-chia Luke	CDM	732-225-7000	luken@cdm.com	Risk Assessor

QAPP Worksheet #9 Project Scoping Session Participants Sheet

Comments/Decisions:

EPA suggested adding contingency soil samples in the event that a source/facility is identified during groundwater screening.

Action Items: EPA will provide access to drilling locations, public supply wells, and a staging area. They will do this through contact with local utilities and the municipal government.

Consensus Decisions:

Soil samples will be collected in the vadose zone at the source facility, if identified. The need for vapor intrusion sampling will be evaluated during field activities for inclusion in the Human Health Risk Assessment. Indoor air and sub slab samples will be collected at 4 residences near the identified source area/facility, if identified.

The field program will include reconnaissance activities, groundwater screening, monitoring well installation, existing public wells and new monitoring wells sampling, sediment/surface water/seepage sampling, groundwater/surface water interaction analysis, synoptic and long term water level measurements, aquifer testing, and ecological characterization. Two rounds of groundwater samples will be collected; the second round will be conducted three months after the first round. Monitoring wells will be sampled for trace level VOC, TCL/TAL parameters, and water quality parameters. EPA recommended sampling for monitored natural attenuation (MNA) parameters and water quality parameters during round 1 only.

QAPP Worksheet #10

Problem Definition

Problem Summary

Tetrachloroethylene (PCE) concentration above the maximum contaminant level (MCL) of 5 µg/L (micrograms per liter) has been detected in groundwater samples from the Puerto Rico Aqueduct and Sewer Authority (PRASA) well Maunabo 1. Related chlorinated solvents were also detected, including 1,1-dichloroethylene (1,1-DCE), cis-1,2-dichloroethylene (cis-1,2-DCE), and trichloroethylene (TCE). The MCL for 1,1-DCE of 7 µg/L was also exceeded. Analytical data is needed to identify the source/s of the volatile organic compounds (VOCs) and define the plume with concentrations above the MCLs. Impact of the groundwater contamination to surface water (Rio Maunabo) and sediment also needs to be determined. Concentrations of semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), target analyte list (TAL) metals and cyanide are needed to determine if additional compounds exceed screening criteria. Additional data (i.e., lithologic logs, geophysical logs, synoptic water levels, MNA parameters, water quality readings, and topographic data) are needed to evaluate the fate and transport of contaminants in groundwater and other impacted media.

Site Description

The Maunabo Area Groundwater Contamination site (a.k.a. the Maunabo Public Supply Wells site) (CERCLIS ID No. PRN000205831) is located in the municipality of Maunabo, in the southeastern coastal area of Puerto Rico (18° 00' 20.6" N latitude and 65° 54' 19.5" W longitude) as shown in Figure 1. The Maunabo Area Groundwater Contamination site consists of a VOC groundwater plume with no identified source(s) of contamination. The size of the plume of contamination has not yet been determined.

The Maunabo Urbano Public Water System consists of four groundwater wells: Maunabo 1, Maunabo 2 (Bordaleza), Maunabo 3 (Calzada), and Maunabo 4 (San Pedro) as shown in Figure 2. All four public supply wells are finished to depths ranging from 80 to 125 feet below ground surface in the Maunabo alluvial valley aquifer. This aquifer generally consists of poorly sorted sand, silt, clay, and gravel alluvium, including lenticular deposits of sand, gravel, and cobbles. The regional direction of groundwater flow in the Maunabo basin is southeast toward the Caribbean Sea.

The Maunabo basin covers about 18 square miles, of which 3.5 square miles comprise an alluvial valley. This area is surrounded by hills ranging from 150 to 1,700 feet above sea level, except to the east where it is bounded by the Caribbean Sea. The area is drained by Rio Maunabo, which has headwaters at Cerro LaTorresilla. Tributaries of Rio Maunabo head in the foothills to the north and south of this alluvial valley.

The Maunabo Urbano Public Water Supply System serves a total population of 13,988 people apportioned equally among the four wells (i.e., 3,497 per well). Therefore, the contaminated wells in this system, Maunabo 1 and 4, serve almost 7,000 people. Wellhead Protection Areas are delineated for the public supply wells, so the plume lies within a designated Wellhead Protection Area.

The limits of the Pandura Sierra Mountain Range run through the north and northeast region of this municipality, in which the Pandura and El Sombrerito hills, at the border with Yabucoa, are the highest elevations. With the exception of the before mentioned elevations, the rest of the territory of Maunabo is quite level. It's for this reason that geographically it is considered part of the Southern Coastal Valley.

QAPP Worksheet #10 Problem Definition

Environmental Background

In March 2002, the Puerto Rico Department of Health (PRDOH) ordered PRASA to close Maunabo 1 because the PCE concentration exceeded the federal MCL of 5 µg/l. However, rather than close this well, PRASA opted to treat the groundwater with carbon filtration tanks at the wellhead. Since then, the detections of PCE in raw groundwater samples from Maunabo 1 have exceeded the MCL on numerous occasions. Post-treatment samples, including tap water samples collected along distribution system downline from Maunabo 1, indicate that PRASA's treatment has not always been effective and that contaminated drinking water in this system is reaching the consumers. During an inspection in August 2004, PRDOH observed that the treatment cylinders at Maunabo 1 lacked the necessary filter medium.

In October 2005, EPA's Site Assessment Team (SAT) 2 collected water samples in Maunabo Wells 1, 2, 3 and 4, and also in the distribution water line as shown in Figure 2. The distribution samples were analyzed for Target Compound List (TCL) organic parameters, Base/Natural Acids (BNA), Pesticide/PCB and TAL inorganic parameters including mercury and cyanide by the EPA Contract Laboratory Program (CLP). The data confirmed the presence of PCE and cis-1,2-DCE in Maunabo 1 and in post-treatment samples along the distribution line. The results also confirmed the presence of 1,1-DCE in Maunabo 4, and an unrelated compound, methyl tert butyl ether (MTBE), in Maunabo 1. Both 1,1-DCE and MTBE were detected in samples from the distribution system. No detections were above MCL in this sampling event except for bis(2-Ethylhexyl) phthalate in Maunabo 3 which was detected at 6.5 µg/L above the MCL of 6 µg/L. Maunabo 2 and Maunabo 3 show "non-detect" background concentrations for PCE; cis 1,2-DCE; 1,1-DCE and MTBE.

In December 2005, the SAT 2 conducted an investigation of possible sources of groundwater contamination in Maunabo. Facilities that were investigated include the former Maunabo Municipal Solid Waste Landfill (Maunabo Landfill), PRASA's Wastewater Treatment Plant located close to Maunabo Well 1, El Negro Auto Body/Parts shop, Total Gas Station, Esso Gas Station, and five light industrial facilities operating under the auspices of the Puerto Rico Industrial Development Corporation (PRIDCO). The locations are shown in Figure 3 except the Maunabo Landfill which is located off Route 759, approximately 1.5 miles west of Maunabo 1.

The five PRIDCO industrial facilities are:

- Centro de Acopio Manufacturing (CAM) - CERCLIS ID No. PRN000205858
- Juan Orozco Limited, Inc. (JUA) - CERCLIS ID No. PRN000205861
- Plastic Home Products (PHP) - CERCLIS ID No. PRN000205862
- Puerto Rico Beverage (PRB) - CERCLIS ID No. PRN000205863
- FEMA Storage Facility (SF) - CERCLIS ID No. PRN000205860

Based on the October and December 2005 data, there is insufficient information to conclusively determine the source of contamination of the local drinking water supply wells. Table 1 shows the sampling summary.

QAPP Worksheet #10 Problem Definition

Project Description

The objective of this RI/FS investigation is to determine the nature and extent of contamination in groundwater at the Maunabo site, in order to assess risks to ecological and human receptors and to evaluate appropriate remedial alternatives. Specifically, the RI is designed to collect information to:

- Find the source/s of contamination
- Determine the rate and direction of groundwater and contamination movement
- Find the extent of groundwater surface water, soil, and sediment contamination
- Identify potentially responsible parties (PRPs)

Project Decision Conditions

- If the boundaries of groundwater contamination exceeding applicable regulatory criteria can be defined, then no further investigations will be conducted to fully establish the contaminant boundaries and develop remedial alternatives.
- If the groundwater/surface interaction is determined, then corrective action to minimize human and ecological risks will be evaluated.
- If sediment contamination exceeds project action limits (see worksheet 15), then sediment remedial alternatives will be evaluated in the feasibility study.
- If the source/s of contamination is not determined, then CDM will confer with EPA to determine the future course of action.
- If the source/s of contamination is identified, CDM will collect soil and air samples in the source area, as stated in the work plan.
- If subsurface soil contamination exceeds project action limits (see worksheet 15), then soil remedial alternatives will be evaluated in the feasibility study.

QAPP Worksheet #11 Project Quality Objectives/Systematic Planning Process Statements

Who Will Use the Data?

EPA, PREQB, and CDM will use the data.

What Will the Data be Used For?

- To determine the area, depth, and extent of groundwater contamination.
- To determine if groundwater discharging into the surface water causes contamination of the water bodies and their sediment.
- To evaluate the interaction of groundwater with surface water.
- To determine if surface water criteria levels have been exceeded.
- To determine if there is a potential current risk to human health or ecological risk from contaminated media at the site that exceed criteria levels
- To evaluate the potential for natural attenuation.
- To determine the source of the groundwater contamination.
- To determine the contamination of the soil at the source area.

What Type of Data are Needed?

The sampling program will include the following:

- Monitoring Well and Municipal Public Supply Well Samples: Trace Level TCL VOCs, TCL SVOCs, methane, ethane, ethene, pesticides/PCBs, TAL metals, and cyanide, nitrate/nitrite, sulfate, sulfide, ferrous iron, total organic carbon (TOC), total suspended solids (TSS), total dissolved solids (TDS), ammonia, hardness, alkalinity and total Kjeldahl nitrogen (TKN).
- Surface Water Samples: Full TCL/TAL parameters (including trace VOCs), alkalinity, ammonia, hardness, nitrate/nitrite, TKN, sulfate, sulfide, chloride, pH, TOC, TDS, and TSS
- Groundwater Screening Samples: Trace VOCs with 24-hour turnaround for faxed results.
- Lithologic Sampling and Logging: Lithologic data for developing the conceptual site model (CSM).
- Source Investigation Soil Samples (contingent, Worksheet # 9): Full TCL/TAL parameters, pH, TOC, and grain size (50% of the samples for the grain size)
- Sediment Samples: Full TCL/TAL parameters, pH, TOC, and grain size.
- Air Samples (contingent, Worksheet # 9): Selected VOCs based on groundwater screening and monitoring well data.
- Gamma Logging: Natural gamma logs to correlate with lithologic logs.
- Aquifer Testing: Slug test at selected monitoring wells. Limited pump test (contingency).
- Field Indicator Parameters: Turbidity, temperature, oxidation-reduction potential (Eh), pH, dissolved oxygen (DO), and specific conductance.
- Long Term Water Level Measurements: Continuous water levels from selected monitoring wells.

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■ **QAPP Worksheet #11**
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- Synoptic Water Level Measurements: Elevation of groundwater table and groundwater flow direction.
- Groundwater/Surface Water Interaction: Water discharge measurements.
- Groundwater Seepage Samples: Trace VOCs, TCL SVOCs, pesticides/PCBs, and TAL metals, cyanide, alkalinity, ammonia, hardness, nitrate/nitrite, TKN, sulfate, sulfide, chloride, TOC, TDS, and TSS.
- Passive Diffusion Bag Samples: Trace VOCs.
- Ecological Field Investigation: General aquatic habitat conditions, vegetation cover, wildlife observation, surficial soil conditions, and indications of environmental stress.

How “good” do the data need to be in order to support the environmental decision?

The project-specific action limits and quantification limits for each sampled media are specified on Worksheet #15 for the all contaminants of potential concern (COPCs). In addition, data will support a risk assessment. All laboratory analyses will be performed by EPA’s Region II DESA laboratory, a CLP laboratory, or a CDM subcontract laboratory. CDM will comply with EPA’s Field and Analytical Service Teaming Advisory Committee (FASTAC) policy for obtaining laboratory resources. Data must meet the data quality objectives (DQOs) that have been specified for the site.

The EPA regional laboratory may not perform some of the analyses proposed for the samples to be collected at the site. For those analyses not available through the CLP, CDM may have to use a subcontractor laboratory, however, CDM will follow the FASTAC procedures.

How much data are needed?

Refer to Worksheets #18 and #20 for full tables of analytical data needs. The following is a summary of the data needs for this RI/FS:

334 Groundwater Screening Samples: LDL VOCs, with 24-hour turn-around for faxed results.

5 Groundwater Seepage Samples: Groundwater seepage samples will be analyzed for trace level VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, cyanide, hardness, alkalinity, ammonia, nitrate/nitrite, TKN, sulfate, sulfide, chloride, TOC, TDS, and TSS.

5 Diffusion Bag Groundwater Seepage Samples: Diffusion bag groundwater seepage samples will be analyzed for trace level VOCs.

7 Surface Water Samples: Surface water samples will be analyzed for trace level VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, cyanide, hardness, alkalinity, ammonia, nitrate/nitrite, TKN, sulfate, sulfide, chloride, TOC, TDS, and TSS.

7 Sediment Samples: Sediment samples will be analyzed for full TCL/TAL parameters, grain size, pH, and TOC.

38 Monitoring Well Samples (2 rounds of 19 wells): Monitoring well samples will be analyzed for trace level VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, cyanide, chloride, methane, ethane, ethene, nitrate/nitrite, sulfate, sulfide, TOC, TSS, TDS, ammonia, alkalinity, hardness, and TKN. DO, Eh, turbidity, pH, conductivity, temperature, and ferrous iron analysis will be conducted onsite.

8 Municipal Public Supply Well Samples (2 rounds of 4 wells): Municipal public supply well samples will be analyzed for TCL VOCs (trace), TCL SVOCs and pesticides/PCBs, TAL metals, cyanide, chloride, methane, ethane, ethene, nitrate/nitrite, sulfate, sulfide, TOC, TSS, TDS, ammonia, alkalinity, hardness, and TKN. DO, Eh, turbidity, pH, conductivity, temperature, and ferrous iron analysis will be conducted onsite.

24 Soil Samples: Soil samples will be analyzed for full TCL/TAL parameters, grain size (50% of the samples), pH, and TOC.

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13 Sub-Slab and Indoor Air Samples: Sub-slab and indoor air samples will be analyzed for selected VOCs based on groundwater screening and monitoring well data by the EPA Method TO-15 method by an EPA laboratory through the Flexibility Clause. The samples will be collected in the vicinity of the Maunabo Contamination.

Lithologic Logs: 4-foot DPT soil cores will be collected at 10-foot intervals at 8 groundwater screening locations for lithologic logging to enhance the CSM and to help select monitoring well locations

Natural Gamma Logs: Natural gamma logs will be run in the deep well of each monitoring well pair, and in the three supply wells to identify clay layers in the overburden and to correlate with the lithologic logs.

Water Level Measurements: Two rounds of synoptic water level measurements will be collected from monitoring wells to calculate water elevations for groundwater contour maps.

Long-Term Water Levels: Long-term water levels will be monitored in four shallow and four deep monitoring wells to evaluate temporal fluctuations in water levels in response to precipitation and local pumping at the supply wells.

Aquifer Tests: Rising-head and falling-head slug test will be performed in 19 select monitoring wells to estimate hydraulic conductivity of the aquifer. Selected wells will represent a variety of depths, lithology types, and locations across the site.

QAPP Worksheet #11

Project Quality Objectives/Systematic Planning Process Statements

Where, when, and how should the data be collected?

The samples will be collected in the vicinity of the Maunabo Contamination Site as shown on Figures 5, 6, and 7. Figure 4 shows the project schedule. Worksheets #17 detail the sampling program design and rationale. Worksheet #18 shows the sampling locations and methods. Worksheet # 21 provides the SOPs that govern the various types of sampling. Sampling SOPs are provided in Appendix B.

Who will collect and generate the data?

CDM and subcontractors to CDM will collect the analytical samples that will be shipped to DESA, CLP, and/or CDM's subcontract laboratory for analysis. A drilling contractor will drill the boreholes and install the monitoring wells. CDM will perform the lithologic logging, water level measurement, field test kit analysis gamma logging and slug test. A licensed surveyor will develop a detailed topographic map of the site and surrounding area and survey the location and elevation of all monitoring wells that will be installed during the RI/FS. A cultural resources subcontractor will conduct a Phase IA survey of the local area. A subcontractor will sample and dispose of investigation derived waste (IDW).

How will the data be reported?

Validated analytical data will be forwarded to CDM from DESA and/or CLP for evaluation and use in the RI Report, human health risk assessment (HHRA), screening level risk assessment (SLERA), and FS. Analytical data generated by laboratories under subcontract to CDM will be received in electronic and hard copy and validated by CDM personnel. Following completion of all laboratory analysis and receipt of all electronic and hard-copy data, an RI report will be generated by CDM and submitted to EPA, and PREQB. CDM will use geographic information system (GIS) to facilitate spatial analysis of data and to generate figures for reports and presentations. CDM will develop a CSM based on information collected from the geology, hydrogeology, and hydrology investigations.

How will the data be archived?

- Preliminary data (Form 1s) will be faxed or e-mailed to CDM within the specified turnaround time.
- Data from CDM's subcontract laboratories will be received in electronic and hard copy format specified in the contract and validated by CDM personnel.
- Final CLP validated data will be submitted to CDM in electronic format and hard copy consistent with CLP deliverables.
- Electronic data will be input into the project's database.
- EPA will archive CLP laboratory raw data.
- Hard copies of analytical data received by CDM will be archived in the project files and the RAC 2 document control system.

QAPP Worksheet #12a Measurement Performance Criteria Table

Matrix – Aqueous Groundwater Screening, Surface Water and Monitoring Well Samples & Field Blanks					
Analytical Group/Concentration Level Trace VOCs (24 hour TAT)					
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria ¹ (MPC)	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling PSOP 1, Passive Diffusion Bag Water Sampling SOP 1-5, Groundwater Sampling Using Bailers SOP 1-9, Supply Well (Tap Water) Sampling TSOP 3-1 Geoprobe sampling Site-Specific Low Flow SOP (App. A)	SOM01.2 with SIM for trace water	Precision	RPD \leq 50% ² ABS \leq 5xCRQL	Field Duplicates ^{3,4}	S&A
		Accuracy/Bias	60-140% recovery for COPCs ⁶	Surrogate Spikes	A
		Accuracy	\leq CRQLs ⁵	Equipment Rinsate Blanks	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq CRQLs ⁵	Method Blank	A
		Completeness	\geq 90%	Data assessment	S&A
		Comparability	Similar Units (μ g/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet project quantitation limit goals (PQLGs) ⁵	Data assessment	S

Notes:

- Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
 - RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
 - Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
 - Under method SOM01.2, no matrix spike/matrix spike duplicate (MS/MSD) is required for VOCs.
 - See Worksheet # 15a and # 15f for sensitivity requirements and CRQL values.
 - The chemicals of potential concern (COPCs) include PCE, 1,1-DCE, cis-1,2-DCE, and TCE.
 - EPA CLP generated data is validated using the same data validation SOP and criteria.
- SIM = Simultaneous Ion Monitoring TAT = turnaround time
For Worksheet #12 DESA requirements are included in Appendix G

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QAPP Worksheet #12b Measurement Performance Criteria Table

Matrix – Aqueous Surface Water, Monitoring Well Samples and Field Blanks					
Analytical Group	TCL SVOCs				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria ¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers TSOP 1-9, Supply Well (Tap Water) Sampling Project-specific Low Flow SOP for Groundwater (App. A)	SOM01.2 Low water with SIM	Precision	$RPD \leq 50\%^2$ $ABS \leq 5 \times CRQL$	Field Duplicates ^{3,4}	S&A
		Accuracy/Bias	60-140% recovery	Surrogate Spikes	A
		Accuracy	$\leq CRQLs^5$	Equipment Rinsate Blanks	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	$\leq CRQLs^5$	Method Blank	A
		Completeness	$\geq 90\%$	Data assessment	S&A
		Comparability	Similar Units ($\mu g/L$)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Under method SOM01.2, no matrix spike/matrix spike duplicate (MS/MSD) is required for VOCs.
5. See Worksheet # 15b and # 15g for sensitivity requirements and CRQL values.

QAPP Worksheet #12c
Measurement Performance Criteria Table

Matrix – Aqueous Surface Water, Monitoring Well Samples and Field Blanks					
Analytical Group	TCL Pesticides				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers SOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater (App. A)	SOM01.2 Low water	Precision	RPD \leq 50% ² ABS \leq 5xCRQL	Field Duplicates ³	S&A
		Precision	RPD \leq 40%	Analytical Duplicates ⁴	A
		Accuracy/Bias	50-150% recovery	Surrogate Spikes	A
		Accuracy	\leq CRQLs ⁵	Equipment Rinsate Blanks	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq CRQLs ⁵	Method Blank	A
		Completeness	\geq 90%	Data assessment	S&A
		Comparability	Similar Units (μ g/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the MS/MSD.
5. See Worksheet # 15c and # 15h for sensitivity requirements and CRQL values.

**QAPP Worksheet #12d
Measurement Performance Criteria Table**

Matrix – Aqueous Surface Water, Monitoring Well Samples and Field Blanks					
Analytical Group	TCL PCBs				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers SOP 1-9, Supply Well Sampling (Tap Water); and Project-specific Low Flow SOP for Groundwater (App. A)	SOM01.2 Low water	Precision	RPD \leq 50% ² ABS \leq 5xCRQL	Field Duplicates ³	S&A
		Precision	RPD \leq 40%	Analytical Duplicates ⁴	A
		Accuracy/Bias	60-120% recovery	Surrogate Spikes	A
		Accuracy	\leq CRQLs ⁵	Equipment Rinsate Blanks	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq CRQLs ⁵	Method Blank	A
		Completeness	\geq 90%	Data assessment	S&A
		Comparability	Similar Units (μ g/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the MS/MSD.
5. See Worksheet # 15c and # 15h for sensitivity requirements and CRQL values.

QAPP Worksheet #12e Measurement Performance Criteria Table

Matrix – Aqueous Surface Water, Monitoring Well Samples and Field Blanks					
Analytical Group	TAL Metals, Mercury and Cyanide				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers SOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater (App. A)	ILM05.4	Precision	$RPD \leq 50\%^2$ $ABS \leq 5 \times CRQL$	Field Duplicates ³	S&A
	ICP-AES ICP-MS	Precision	$RPD \leq 40\%$	Laboratory Duplicates ⁴	A
		Accuracy/Bias	75-125% recovery	Matrix Spikes	A
		Accuracy	$\leq CRQLs^5$	Equipment Rinsate Blanks	S
		Accuracy/Bias	80–120%	Laboratory Control Samples	A
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	$\leq CRQLs^5$	Method Blank	A
		Completeness	$\geq 90\%$	Data assessment	S&A
		Comparability	Similar Units ($\mu g/L$)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
 2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
 3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
 4. Precision will be determined from the MS/MSD.
 5. See Worksheet #15d and # 15i for sensitivity requirements and CRQL values.
- ICP-AES = inductively coupled plasma-atomic emission spectroscopy ICP-MS = inductively coupled plasma-mass spectroscopy

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**QAPP Worksheet #12f
Measurement Performance Criteria Table**

Matrix – Aqueous Surface Water and Monitoring Well Samples					
Analytical Group	Alkalinity, Ammonia and TKN				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers SOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater (App. A)	Alkalinity- EPA 310.1, Ammonia – EPA 350.1/350.2 TKN EPA 351.2/351.4	Precision	RPD \leq 50% ² ABS \leq 5xQL	Field Duplicates ³	S&A
		Precision	RPD \leq 40%	Analytical Replicates and Duplicates ⁴	A
		Accuracy/Bias	80-120% recovery	LCS	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq QLS ⁵	Method Blank	A
		Completeness	\geq 90%	Data assessment	S&A
		Comparability	Similar Units (mg/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the laboratory duplicate results.
5. See Worksheet # 15e and # 15j for sensitivity requirements and QL values.

**QAPP Worksheet #12g
Measurement Performance Criteria Table**

Matrix – Aqueous Surface Water and Monitoring Well Samples					
Analytical Group	Hardness, TDS and TSS				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers SOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater (App. A)	Hardness- EPA 130.1/130.2	Precision	RPD \leq 50% ² ABS \leq 5xQL	Field Duplicates ³	S&A
		Precision	RPD \leq 40%	Analytical Replicates/ Duplicates ⁴	A
		Accuracy/Bias	80-120% recovery	LCS	S
	ILM05.4 or 200.7 with calculation	Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq QLs ⁵	Method Blank	A
		Completeness	\geq 90%	Data Assessment	S&A
	TDS – EPA 160.1	Comparability	Similar Units (mg/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data Assessment	S
	TSS - EPA 160.2				

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the laboratory duplicate results.
5. See Worksheet # 15b and # 15g for sensitivity requirements and QL values.

QAPP Worksheet #12h Measurement Performance Criteria Table

Matrix – Aqueous Surface Water and Monitoring Well Samples					
Analytical Group	Chloride, Nitrate, Sulfate, and Sulfide				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers SOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater (App. A)	Chloride EPA 300.0/325.1	Precision	$RPD \leq 50\%^2$ $ABS \leq 5xQL$	Field Duplicates ³	S&A
		Precision	$RPD \leq 40\%$	Analytical Replicates/ Duplicates ⁴	A
	Nitrate EPA 300.0/352.1	Accuracy/Bias	80-120% recovery	LCS	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
	Sulfate EPA 300.0/375.3/375.4	Sensitivity	$\leq QLs^5$	Method Blank	A
		Completeness	$\geq 90\%$	Data Assessment	S&A
		Comparability	Similar Units ($\mu g/L$)	Data Review - Compare results from each round	S&A
	Sulfide EPA 376.1/376.2	Sensitivity	Detection Limits meet PQLGs ⁵	Data Assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the laboratory duplicate results.
5. See Worksheet # 15e and # 15j for sensitivity requirements and QL values.

**QAPP Worksheet #12i
Measurement Performance Criteria Table**

Matrix – Aqueous Surface Water and Monitoring Well Samples					
Analytical Group	TOC				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Technical Standard Operating Procedure (TSOP) 1-1, Surface Water Sampling TSOP 1-5 Groundwater Seepage Samples Using Bailers TSOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater (App. A)	EPA 415.1/415.2	Precision	RPD \leq 50% ² ABS \leq 5xQL	Field Duplicates ³	S&A
		Precision	RPD \leq 40%	Analytical Replicates/Duplicates ⁴	A
		Accuracy/Bias	80-120% recovery	LCS	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq QLS ⁵	Method Blank	A
		Completeness	\geq 90%	Data assessment	S&A
		Comparability	Similar Units (μ g/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the laboratory duplicate results.
5. See Worksheet # 15e and # 15j for sensitivity requirements and QL values.

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QAPP Worksheet #12j
Measurement Performance Criteria Table

Matrix – Aqueous Monitoring Well Samples					
Analytical Group	Methane, Ethane and Ethene				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater (App. A)	RSK 175	Precision	RPD \leq 50% ² ABS \leq 5xQL	Field Duplicates ³	S&A
		Precision	RPD \leq 40%	Analytical Replicates and Duplicates ⁴	A
		Accuracy/Bias	75-125% recovery	Matrix Spikes	A
		Accuracy/Bias	80-120%	LCS	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq QLs ⁵	Method Blank	A
		Completeness	\geq 90%	Data assessment	S&A
		Comparability	Similar Units (µg/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
4. Precision will be determined from the laboratory duplicate results.
5. See Worksheet # 15e for sensitivity requirements and QL values.

QAPP Worksheet #12k
Measurement Performance Criteria Table

Matrix – Aqueous Monitoring Well Samples					
Analytical Group	Ferrous Iron				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-9, Supply Well Sampling (Tap Water) Project-specific Low Flow SOP for Groundwater	HACH 8146	Precision	RPD \leq 50% ¹ ABS \leq 5xQL	Field Duplicates ²	S&A
		Precision	RPD \leq 50%	Analytical Replicates/Duplicates ³	A
		Accuracy/Bias	75-125% recovery	Accuracy Check Sample	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq EDLs ⁴	Water Blank	A
		Completeness	\geq 90%	Data assessment	S&A
		Comparability	Similar Units (μ g/L)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁴	Data assessment	S

Notes:

1. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
2. Only the field duplicate results will be affected by data validation or data assessment actions resulting from failure to achieve these MPCs.
3. Precision will be determined from the analytical replicate or duplicate results.
4. See Worksheet # 15e for sensitivity requirements and QL values.

**QAPP Worksheet #121
Measurement Performance Criteria Table**

Matrix	Soil/Sediment				
Analytical Group	TCL VOCs				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface Soil Sampling TSOP 1-3 Surface Soil Sampling TSOP 1-11 Sediment/Sludge Sampling TSOP 3-1 Geoprobe® Sampling	SOM01.2 Low soil + modification	Precision	$RPD \leq 100\%^2$ $ABS \leq 5 \times CRQL$	Field Duplicates ^{3, 4} (Co-located)	S&A
		Accuracy	60-120% recovery	Surrogate Spikes	A
		Accuracy	$\leq CRQLs^5$	Accuracy	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	$\leq CRQLs^5$	Method Blank	A
		Completeness	$\leq 90\%$	Data assessment	S&A
		Comparability	Similar Units ($\mu g/kg$)	Data Review - Compare results from each round Review	S&A
		Sensitivity	Detection Limits meet project quantitation limits (PQLGs) ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs will be calculated for all detected results. The ABS will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.
4. Under method SOM01.2, no MS/MSD is required for VOCs.
5. See Worksheet # 15k and # 15p for sensitivity requirements and CRQL values.

**QAPP Worksheet #12m
Measurement Performance Criteria Table**

Matrix	Soil/Sediment				
Analytical Group	TCL SVOCs				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface soil sampling TSOP 1-3 Surface Soil Sampling TSOP 1-11 Sediment/Sludge Sampling TSOP 3-1 Geoprobe Sampling	SOM01.2 Low soil + modification	Precision	$RPD \leq 100\%^2$ $ABS \leq 5 \times CRQL$	Field Duplicates ^{3,4} (Co-located)	S&A
		Accuracy	60-120% recovery for COPCs	Surrogate Spikes	A
		Accuracy	$\leq CRQLs$	Equipment Rinsate Blank	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	$\leq CRQLs$	Method Blank	A
		Completeness	$\leq 90\%$	Data assessment	S&A
		Comparability	Similar Units ($\mu g/kg$)	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁵	Data assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs will be calculated for all detected results. The ABS will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.
4. Under method SOM01.2 no MS/MSD required for SVOCs.
5. See Worksheet # 15l and 15q for sensitivity requirements and CRQL values.

QAPP Worksheet #12n
Measurement Performance Criteria Table

Matrix	Soil/Sediment				
Analytical Group	TCL Pesticides				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface Soil Sampling TSOP 1-3 Surface Soil Sampling TSOP 1-11 Sediment/Sludge Sampling TSOP 3-1 Geoprobe Sampling	SOM01.2 Low soil + modification	Precision	RPD \leq 100% ²	Field Duplicates ³	S&A
			ABS \leq 5xCRQL	(Co-located)	
		Precision	\leq 40%	Analytical Duplicates (MS/MSD)	A
		Accuracy	60-120% recovery for COCs	MS or Surrogate Spikes	A
		Accuracy	\leq CRQLs	Equipment Rinse Blanks	S
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
		Sensitivity	\leq CRQLs	Method Blanks	A
		Completeness	\geq 90%	Data Assessment	S&A
		Comparability	Units μ g/kg	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs	Data Assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.
4. See Worksheet # 15m and 15r for sensitivity requirements and CRQL values.

QAPP Worksheet #12o
Measurement Performance Criteria Table

Matrix	Soil/Sediment				
Analytical Group	TCL PCBs				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface soil sampling TSOP 1-3 Surface Soil Sampling TSOP 1-11 Sediment/Sludge Sampling TSOP 3-1 Geoprobe Sampling	SOM01.2 Low soil	Precision	$RPD \leq 100\%^2$	Field Duplicates ³	S&A
			$ABS \leq 5 \times CRQL$	(Co-located)	
		Precision	$\leq 40\%$	Analytical Duplicates (MS/MSD)	A
		Accuracy	60-120% recovery for COCs	MS or Surrogate Spikes	A
		Accuracy	$\leq CRQLs$	Equipment Rinsate Blanks	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	$\leq CRQLs$	Method Blanks	A
		Completeness	$\geq 90\%$	Data Assessment	S&A
		Comparability	Units $\mu g/kg$	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁴	Data Assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.
4. See Worksheet # 15m and 15r for sensitivity requirements.

**QAPP Worksheet #12p
Measurement Performance Criteria Table**

Matrix	Soil/Sediment				
Analytical Group	TAL Metals, Cyanide and Mercury				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface soil sampling TSOP 1-3 Surface Soil Sampling TSOP 1-11 Sediment/Sludge Sampling TSOP 3-1 Geoprobe Sampling	ILM05.4 ICP-AES + modification for antimony and thallium	Precision	$RPD \leq 100\%^2$ $ABS \leq 5 \times CRQL$	Field Duplicates ³	S&A
		Precision	RPD +/- 40%	Laboratory Duplicates	A
		Accuracy/Bias	75-125% recovery	Matrix Spikes	A
		Accuracy/Bias	80-120% recovery	Laboratory Control Sample	A
		Accuracy	$\leq CRQLs$	Equipment Rinsate Blanks	S
		Accuracy	± 6 degrees Celsius	Temperature Blank	S
		Sensitivity	$\leq CRQLs$	Method Blanks	A
		Completeness	$\geq 90\%$	Data Assessment	S&A
		Comparability	Units mg/kg	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQLGs ⁴	Data Assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.
4. See Worksheet # 15n and 15s for sensitivity requirements and CRDL values.

**QAPP Worksheet #12q
Measurement Performance Criteria Table**

Matrix	Soil/Sediment				
Analytical Group	pH, TOC and grain size				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-4 Subsurface Soil Sampling	Grain size- ASTM D421-85 & D422-63	Precision	RPD \leq 100% ²	Field Duplicates ³	S&A
			ABS \leq 5xQL		
TSOP 1-3 Surface Soil Sampling	pH - SW-846, 9045C	Precision	RPD +/- 40%	Laboratory Duplicates	A
		Accuracy/Bias	75-125% recovery	Mid-Verification Standard (TOC)	A
TSOP 1-11 Sediment/Sludge Sampling	TOC - Lloyd Kahn	Accuracy/Bias	80-120% recovery	Laboratory Control Sample (pH)	A
		Accuracy	\pm 6 degrees Celsius	Temperature Blank	S
TSOP 3-1 Geoprobe Sampling		Sensitivity	\leq CRQLs	Preparation Blanks	A
		Completeness	\geq 90%	Data Assessment	S&A
		Comparability	Units mg/kg	Data Review - Compare results from each round	S&A
		Sensitivity	Detection Limits meet PQGLs	Data Assessment	S

Notes:

1. Analytical criteria are outlined in the DESA SOPs and CLP statements of work (SOWs). If a subcontract laboratory is utilized, analytical criteria will be outlined in the laboratory SOWs and SOPs.
2. RPDs (relative percent differences) will be calculated for all detected results. The absolute difference (ABS) will be calculated for results failing the RPD and where only one result is detected or results fall below the CRQL. The ABS will be compared to 5 times the CRQL.
3. Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.
4. See Worksheet # 15o and 15t for sensitivity requirements and CRQL values.

QAPP Worksheet #12r
Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	In-Field Measurements				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-1 Surface Water Sampling	NA	Representativeness	± 0.1	pH (standard units)	S&A
			± 3%	Conductivity (µSiemens)	S&A
TSOP 1-5 Groundwater Seepage Sampling Using Bailers			± 10 mV	Redox Potential (Eh) (millivolts)	S&A
			± 10%	Turbidity	S&A
			± 10%	Dissolved Oxygen	S&A
			Flow rate	Monitored in the field (see Low Flow TSOP for flow rate criteria)	S&A
TSOP 1-9 Tap Water Sampling					
Project-specific Low flow SOP					

Note:

NA = Not Applicable

**QAPP Worksheet #12s
Measurement Performance Criteria Table**

Matrix	Air				
Analytical Group	VOCs				
Concentration Level	Low				
Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria¹	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
TSOP 1-8 Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA® Canister	TO-15 (see worksheets # 15u and # 15v)	Precision	$RPD \leq 50\%^2$	Field Duplicates	S&A
		Precision	$RPD \leq 20\%$ for analyte compounds	Analytical Duplicates	A
		Accuracy	$\pm 6\%$ recovery expected value	Audit Standards	A
		Sensitivity	$\leq MDL$	Method Blank	A
		Completeness	$\leq 100\%$ of critical ³ data to be validated	Data Assessment	S&A
		Comparability	Similar Units (ppmv)	Data Review - Compare results from each round Review	S&A
		Sensitivity	Detection Limits meet project quantitation limits (PQGLs)	Data Assessment	S

Notes:

1. Analytical criteria are outlined in the EPA's Air analytical Services Contract.
2. Precision will be determined from the laboratory and field duplicate results
3. Critical data points are those considered of importance for completeness.
4. See Worksheet # 15u and 15v for sensitivity requirements and CRDL values.

QAPP Worksheet #13
Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Groundwater samples were collected from the Maunabo municipal public supply wells and distribution water lines.	Hazard Ranking System (HRS) Documentation Package, Maunabo Groundwater Contamination Site, Maunabo, Puerto Rico: Region 2 Site Assessment Team 2 (SAT 2), Weston Solutions, Inc. March 2006.	EPA Region 2 SAT collected these samples in October 2005.	Data used for determination of potential source areas and range of groundwater plume. Data used for planning purposes during work plan preparation	Sufficient information is not available to ascertain the quality of the data; to be used for qualitative comparison only
Ten sites were investigated in the Maunabo area as potential sources of contamination for the groundwater plume.	HRS Documentation Package Maunabo Groundwater Contamination Site, Maunabo, Puerto Rico: Region 2 Site Assessment Team 2 (SAT 2), Weston Solutions, Inc. March 2006. Preliminary Assessment/Site Inspection Reports. Region 2 Site Assessment Team 2 (SAT 2), Weston Solutions, Inc. September 2006.	EPA Region 2 SAT collected these samples in December 2005.	Data used for determination of potential source areas and range of groundwater plume. Data used for planning purposes during work plan preparation	Sufficient information is not available to ascertain the quality of the data; to be used for qualitative comparison only

QAPP Worksheet #14 Summary of Project Tasks

Sampling Tasks: Sampling tasks are summarized below:

- Groundwater Screening Samples (see worksheet # 26):
 - Transect 1: 10 locations, sample every 10 feet, estimated depth 130 feet below ground surface (bgs)
 - Transect 2: 5 locations, sample every 10 feet, estimated depth 130 feet bgs
 - Transect 3: 5 locations, sample every 10 feet, estimated depth 70 feet bgs
 - Contingent: 3 locations, sample every 10 feet
- Monitoring well samples: 2 rounds of sampling from 19 wells
- Municipal public supply well samples: 2 rounds of sampling from 4 wells
- Surface and Subsurface soil samples (optional): 6 locations, 1 surface and 3 subsurface samples from each location
- Surface water samples - 7 locations, 1 sample per location
- Sediment samples - 7 locations, 1 sample per location
- Groundwater Seepage Samples – 5 locations, 1 sample per location
- Air Samples (optional): 4 locations, 1 initial sample per location, 1 concurrent sub-slab and 1 indoor air sample per location, 1 background ambient air

Analysis Tasks:

Groundwater Screening Samples:	VOCs (trace), with 24-hour turnaround time.
Municipal Public Supply Well Samples:	VOCs (trace), TCL SVOCs, pesticides/PCBs, TAL inorganics, chloride, methane, ethane, ethene, nitrate/nitrite, sulfate, sulfide, ferrous iron, TOC, TSS, TDS, ammonia, hardness, and TKN.
Monitoring Well Samples:	VOCs (trace), TCL SVOCs, pesticides/PCBs, TAL inorganics, chloride, methane, ethane, ethene, nitrate/nitrite, sulfate, sulfide, ferrous iron, TOC, TSS, TDS, ammonia, hardness, and TKN
Source Investigation Soil Samples:	Full TCL/TAL parameters, pH, TOC, and grain size (one-half of the samples for grain size)
Surface Water Samples:	Full TCL/TAL parameters (including trace level VOCs), alkalinity, ammonia, hardness, nitrate/nitrite, TKN, sulfate, sulfide, chloride, pH, TOC, TDS, and TSS
Groundwater Seepage Samples:	Full TCL/TAL parameters (including trace level VOCs), alkalinity, ammonia, hardness, nitrate/nitrite, TKN, sulfate, sulfide, chloride, pH, TOC, TDS, and TSS
Sediment Samples:	Full TCL/TAL parameters, pH, TOC, and grain size.
Air Samples (Sub-Slab and Indoor Air)	Selected VOCs based on groundwater screening and monitoring well data.

Quality Control Tasks: Soil and water will have the following QC samples analyzed: field duplicates, matrix spike/matrix spike duplicates, VOC trip blanks, rinsate blanks, reagent water blanks, and all other QA/QC samples as defined in the method.

Secondary Data: Secondary data listed in Worksheet #13 will be reviewed and used to plan sample locations, but will not be added to the project database.

QAPP Worksheet #14 Summary of Project Tasks

Data Management Tasks: Analytical data will be imported into the Environmental Quality Information System (EQulS) database after validation. Field measurements will also be added to the database. Typical data management tasks are outlined in TSOP 4-8; Maunabo's Environmental Data Management will follow the procedures described in Appendix E.

Documentation and Records: All sample locations will be surveyed. Information regarding samples will be recorded in site logbooks in accordance with TSOP 4-1, field logbook content and control.

QAPP Worksheet #15a
Reference Limits and Evaluation Table - Groundwater VOCs

Volatile Organic Compounds^ (All units: microgram per Liter (µg/L))	CAS Number	Criteria		PAL	Project Quantitation Limit Goal (PQLG)^4	Analytical Method			Achievable Laboratory Limits	
		Federal/ Commonwealth	Risk Assessment			MDLs	CRQL		MDLs	QLs
		Primary Drinking Water Standards ^{1,2}	Human Health Screening Value ³				Analytical Method - SOM01.2 Trace Water by SIM	Analytical Method - SOM01.2 Trace Water		
1,1,1-Trichloroethane	71-55-6	200	910	200	40	N/A	NL	0.5	N/A	N/A
1,1,2,2-Tetrachloroethane	79-34-5	NL	0.067	0.067	0.067	N/A	NL	0.5	N/A	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	5900	5,900	1,180	N/A	NL	0.5	N/A	N/A
1,1,2-Trichloroethane	79-00-5	5	0.24	0.24	0.24	N/A	NL	0.5	N/A	N/A
1,1-Dichloroethane	75-34-3	NL	2.4	2.4	0.50	N/A	NL	0.5	N/A	N/A
1,1-Dichloroethene	75-35-4	7	34	7	1	N/A	NL	0.5	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	NL	NL	0.5	0.5	N/A	NL	0.5	N/A	N/A
1,2,4-Trichlorobenzene	120-82-1	9	0.82	0.82	0.50	N/A	NL	0.5	N/A	N/A
1,2-Dibromo-3-chloropropane	96-12-8	0.20	0.00032	0.00032	0.00032	N/A	0.05	0.5	N/A	N/A
1,2-Dibromoethane	106-93-4	0.05	0.0065	0.0065	0.0006	N/A	0.05	0.5	N/A	N/A
1,2-Dichlorobenzene	95-50-1	600	37	37	7.40	N/A	NL	0.5	N/A	N/A
1,2-Dichloroethane	107-06-2	5	0.15	0.15	0.15	N/A	NL	0.5	N/A	N/A
1,2-Dichloropropane	78-87-5	5	0.39	0.39	0.39	N/A	NL	0.5	N/A	N/A
1,3-Dichlorobenzene	541-73-1	NL	NL	0.5	0.5	N/A	NL	0.5	N/A	N/A
1,4-Dichlorobenzene	106-46-7	75	0.43	0.43	0.43	N/A	NL	0.5	N/A	N/A
1,4-Dioxane	123-91-1	NL	6.1	6.1	1.22	N/A	NL	NL	N/A	N/A
2-Butanone	78-93-3	NL	710	710	142	N/A	NL	5	N/A	N/A
2-Hexanone	591-78-6	NL	NL	0.5	0.5	N/A	NL	5	N/A	N/A
4-Methyl-2-pentanone	108-10-1	NL	200	200	40	N/A	NL	5	N/A	N/A
Acetone	67-64-1	NL	2200	2,200	440	N/A	NL	5	N/A	N/A
Benzene	71-43-2	5	0.41	0.41	0.41	N/A	NL	0.5	N/A	N/A
Bromochloromethane	74-97-5	NL	NL	0.5	0.5	N/A	NL	0.5	N/A	N/A
Bromodichloromethane	75-27-4	80	1.1	1.1	0.50	N/A	NL	0.5	N/A	N/A
Bromoform	75-25-2	80	8.5	8.5	1.70	N/A	NL	0.5	N/A	N/A
Bromomethane	74-83-9	NL	0.87	0.87	0.50	N/A	NL	0.5	N/A	N/A
Carbon Disulfide	75-15-0	NL	100	100	20	N/A	NL	0.5	N/A	N/A
Carbon tetrachloride	56-23-5	5	0.2	0.2	0.20	N/A	NL	0.5	N/A	N/A
Chlorobenzene	108-90-7	100	9.1	9	2	N/A	NL	0.5	N/A	N/A
Chloroethane	75-00-3	NL	2100	2,100	420	N/A	NL	0.5	N/A	N/A
Chloroform	67-66-3	80	0.19	0.19	0.19	N/A	NL	0.5	N/A	N/A
Chloromethane	74-87-3	NL	1.8	1.8	0.50	N/A	NL	0.5	N/A	N/A
cis-1,2-Dichloroethene	156-59-2	70	37	37	7	N/A	NL	0.5	N/A	N/A
cis-1,3-Dichloropropene	10061-01-5	NL	NL	0.5	0.5	N/A	NL	0.5	N/A	N/A

QAPP Worksheet #15a
Reference Limits and Evaluation Table - Groundwater VOCs

Volatile Organic Compounds^ (All units: microgram per Liter (µg/L))	CAS Number	Criteria		PAL	Project Quantitation Limit Goal (PQLG)^4	Analytical Method			Achievable Laboratory Limits	
		Federal/ Commonwealth	Risk Assessment			MDLs	CRQL		MDLs	QLs
		Primary Drinking Water Standards ^{1,2}	Human Health Screening Value ³				Analytical Method - SOM01.2 Trace Water by SIM	Analytical Method - SOM01.2 Trace Water		
Cyclohexane	110-82-7	NL	1300	1,300	260	N/A	NL	0.5	N/A	N/A
Dibromochloromethane	124-48-1	80	0.8	0.8	0.50	N/A	NL	0.5	N/A	N/A
Dichlorodifluoromethane	75-71-8	NL	39	39	7.80	N/A	NL	0.5	N/A	N/A
Ethylbenzene	100-41-4	700	1.5	1.5	0.50	N/A	NL	0.5	N/A	N/A
Isopropylbenzene	98-82-8	NL	68	68	13.60	N/A	NL	0.5	N/A	N/A
m, p-Xylene *	1330-20-7	10,000	20	20	4.00	N/A	NL	0.5	N/A	N/A
Methyl acetate	79-20-9	NL	3700	3,700	740.00	N/A	NL	0.5	N/A	N/A
Methyl tert-butyl ether	1634-04-4	NL	12	12	2.40	N/A	NL	0.5	N/A	N/A
Methylcyclohexane	108-87-2	NL	NL	0	0.00	N/A	NL	0.5	N/A	N/A
Methylene chloride	75-09-2	5	4.8	4.8	0.96	N/A	NL	0.5	N/A	N/A
o-Xylene **	1330-20-7	10,000	20	20	4.00	N/A	NL	0.5	N/A	N/A
Styrene	100-42-5	100	160	100	20.00	N/A	NL	0.5	N/A	N/A
Tetrachloroethene	127-18-4	5	0.11	0.11	0.11	N/A	NL	0.5	N/A	N/A
Toluene	108-88-3	1,000	230	230	46.00	N/A	NL	0.5	N/A	N/A
trans-1,2-Dichloroethene	156-60-5	100	11	11	2.20	N/A	NL	0.5	N/A	N/A
trans-1,3-Dichloropropene	10061-02-6	NL	NL	0.0	0.40	N/A	NL	0.5	N/A	N/A
Trichloroethene	79-01-6	5	1.7	1.7	0.50	N/A	NL	0.5	N/A	N/A
Trichlorofluoromethane	75-69-4	NL	130	130	26.00	N/A	NL	0.5	N/A	N/A
Vinyl Chloride	75-01-4	2	0.016	0.016	0.016	N/A	NL	0.5	N/A	N/A

Notes:

- EPA National Primary Drinking Water Standards (web page <http://www.epa.gov/safewater/contaminants/index.html>), EPA 816-F-03-016, June 2003. last updated November 28, 2006.
 - Puerto Rico Groundwater Quality Standards (PRGQS) Regulation, As Amended. March 28, 2003.
Received from Puerto Rico Environmental Quality Board
 - EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
 - If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
- ^ - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.
- * m-xylene and p-xylene reported as one compound under SOM01.2. Xylene (total) was used for m,p-xylene criteria.
- ** Xylene (total) was used for o-xylene criteria.

For Worksheet #15 DESA requirements are included in Appendix G

Acronyms:

EPA = United States Environmental Protection Agency
MDL = method detection limit

CAS = Chemical abstract service
N/A = Not Applicable

CRQL = Contract Required Quantitation Limit
NL = Not Listed or chemical name listed but no value available

QAPP Worksheet #15b
Reference Limits and Evaluation Table - Groundwater SVOCs

Semi-Volatile Organic Compounds^ (All units: microgram per Liter (µg/L))	CAS Number	Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁴	Analytical Method			Achievable Laboratory Limits	
		Federal/ Commonwealth	Risk Assessment			MDLs	CRQL		MDLs	QLs
		Primary Drinking Water Standards ^{1, 2}	Human Health Screening Value ³				Analytical Method - SOM01.2 Low Water by SIM	Analytical Method - SOM01.2 Low Water		
1,1'-Biphenyl	92-52-4	NL	180	180	5	N/A	NL	5	N/A	N/A
1,2,4,5-Tetrachlorobenzene	95-94-3	NL	1.1	1.1	1.1	N/A	NL	5	N/A	N/A
2,2'-Oxybis (1-chloropropane)	108-60-1	NL	0.32	0.32	0.32	N/A	NL	5	N/A	N/A
2,3,4,6-Tetrachlorophenol	58-90-2	NL	110	110	22	N/A	NL	5	N/A	N/A
2,4,5-Trichlorophenol	95-95-4	NL	370	370	74	N/A	NL	5	N/A	N/A
2,4,6-Trichlorophenol	88-06-2	NL	6.1	6.1	5	N/A	NL	5	N/A	N/A
2,4-Dichlorophenol	120-83-2	NL	11	11	5	N/A	NL	5	N/A	N/A
2,4-Dimethylphenol	105-67-9	NL	73	73	14.6	N/A	NL	5	N/A	N/A
2,4-Dinitrophenol	51-28-5	NL	7.3	7.3	7.3	N/A	NL	10	N/A	N/A
2,4-Dinitrotoluene	121-14-2	NL	7.3	7.3	5	N/A	NL	5	N/A	N/A
2,6-Dinitrotoluene	606-20-2	NL	3.7	3.7	3.7	N/A	NL	5	N/A	N/A
2-Chloronaphthalene	91-58-7	NL	290	290	58	N/A	NL	5	N/A	N/A
2-Chlorophenol	95-57-8	NL	18	18	5	N/A	NL	5	N/A	N/A
2-Methylnaphthalene	91-57-6	NL	15	15	5	N/A	0.1	5	N/A	N/A
2-Methylphenol	95-48-7	NL	180	180	36	N/A	NL	5	N/A	N/A
2-Nitroaniline	88-74-4	NL	11	11	5	N/A	NL	10	N/A	N/A
2-Nitrophenol	88-75-5	NL	NL	0	0	N/A	NL	5	N/A	N/A
3,3'-Dichlorobenzidine	91-94-1	NL	0.15	0.15	0.15	N/A	NL	5	N/A	N/A
3-Nitroaniline	99-09-2	NL	3.2	3.2	3.2	N/A	NL	10	N/A	N/A
4,6-Dinitro-2-methylphenol	534-52-1	NL	0.37	0.37	0.37	N/A	NL	10	N/A	N/A
1-bromo-4-phenoxy-Benzene	101-55-3	NL	NL	0	0	N/A	NL	5	N/A	N/A
4-Chloro-3-methylphenol	59-50-7	NL	NL	0	0	N/A	NL	5	N/A	N/A
4-Chloroaniline	106-47-8	NL	1.2	1.2	1.2	N/A	NL	5	N/A	N/A
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	0	0	N/A	NL	5	N/A	N/A
4-Methylphenol	106-44-5	NL	18	18	5	N/A	NL	5	N/A	N/A
4-Nitroaniline	100-01-6	NL	3.2	3.2	3.2	N/A	NL	10	N/A	N/A
4-Nitrophenol	100-02-7	NL	NL	0	0	N/A	NL	10	N/A	N/A
Acenaphthene	83-32-9	NL	220	220	44	N/A	0.1	5	N/A	N/A
Acenaphthylene	208-96-8	NL	220	220	44	N/A	0.1	5	N/A	N/A
Acetophenone	98-86-2	NL	370	370	74	N/A	NL	5	N/A	N/A
Anthracene	120-12-7	NL	1100	1100	220	N/A	0.1	5	N/A	N/A
Atrazine	1912-24-9	3	0.29	0.29	0.29	N/A	NL	5	N/A	N/A
Benzaldehyde	100-52-7	NL	370	370	74	N/A	NL	5	N/A	N/A
Benzo (a) anthracene	56-55-3	NL	0.029	0.029	0.002	N/A	0.1	5	N/A	N/A

QAPP Worksheet #15b
Reference Limits and Evaluation Table - Groundwater SVOCs

Semi-Volatile Organic Compounds^ (All units: microgram per Liter (µg/L))	CAS Number	Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁴	Analytical Method			Achievable Laboratory Limits	
		Federal/ Commonwealth	Risk Assessment			MDLs	CRQL		MDLs	QLs
		Primary Drinking Water Standards ^{1, 2}	Human Health Screening Value ³				Analytical Method - SOM01.2 Low Water by SIM	Analytical Method - SOM01.2 Low Water		
Benzo (a) pyrene	50-32-8	0.2	0.0029	0.0029	0.0029	N/A	0.1	5	N/A	N/A
Benzo (b) fluoroanthene	205-99-2	NL	0.029	0.029	0.002	N/A	0.1	5	N/A	N/A
Benzo (g,h,i) perylene	191-24-2	NL	110	110	22	N/A	0.1	5	N/A	N/A
Benzo (k) fluoroanthene	207-08-9	NL	0.29	0.29	0.002	N/A	0.1	5	N/A	N/A
Bis (2-chloroethoxy) methane	111-91-1	NL	11	11	5	N/A	NL	5	N/A	N/A
Bis (2-ethylhexyl) phthalate	117-81-7	6	4.8	4.8	4.8	N/A	NL	5	N/A	N/A
bis-(2-chloroethyl) ether	111-44-4	NL	0.012	0.012	0.012	N/A	NL	5	N/A	N/A
Butylbenzylphthalate	85-68-7	NL	35	35	7	N/A	NL	5	N/A	N/A
Caprolactam	105-60-2	NL	1800	1800	360	N/A	NL	5	N/A	N/A
Carbazole	86-74-8	NL	NL	0	3.4	N/A	NL	5	N/A	N/A
Chrysene	218-01-9	NL	2.9	2.9	2.9	N/A	0.1	5	N/A	N/A
Dibenzo (a,h)-anthracene	53-70-3	NL	0.0029	0.0029	0.0029	N/A	0.1	5	N/A	N/A
Dibenzofuran	132-64-9	NL	NL	5	5	N/A	NL	5	N/A	N/A
Diethylphthalate	84-66-2	NL	2900	2900	580	N/A	NL	5	N/A	N/A
Dimethylphthalate	131-11-3	NL	NL	0	0	N/A	NL	5	N/A	N/A
Di-n-butylphthalate	84-74-2	NL	370	370	74	N/A	NL	5	N/A	N/A
Di-n-octylphthalate	117-84-0	NL	NL	0	0	N/A	NL	5	N/A	N/A
Fluoranthene	206-44-0	NL	150	150	30	N/A	0.1	5	N/A	N/A
Fluorene	86-73-7	NL	150	150	30	N/A	0.1	5	N/A	N/A
Hexachlorobenzene	118-74-1	1	0.042	0.042	0.04	N/A	NL	5	N/A	N/A
Hexachlorobutadiene	87-68-3	NL	0.86	0.86	0.5	N/A	NL	5	N/A	N/A
Hexachlorocyclo-pentadiene	77-47-4	50	22	22	5	N/A	NL	5	N/A	N/A
Hexachloroethane	67-72-1	NL	4.8	4.8	4.8	N/A	NL	5	N/A	N/A
Indeno (1,2,3-cd)-pyrene	193-39-5	NL	0.029	0.029	0.029	N/A	0.1	5	N/A	N/A
Isophorone	78-59-1	NL	71	71	14.2	N/A	NL	5	N/A	N/A
Napthalene	91-20-3	NL	0.14	0.14	0.1	N/A	0.1	5	N/A	N/A
Nitrobenzene	98-95-3	NL	0.34	0.34	0.34	N/A	NL	5	N/A	N/A
N-Nitroso-di-n propylamine	621-64-7	NL	0.0096	0.0096	0.0096	N/A	NL	5	N/A	N/A

QAPP Worksheet #15b
Reference Limits and Evaluation Table - Groundwater SVOCs

Semi-Volatile Organic Compounds^ (All units: microgram per Liter (µg/L))	CAS Number	Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁴	Analytical Method			Achievable Laboratory Limits	
		Federal/ Commonwealth	Risk Assessment			MDLs	CRQL		MDLs	QLs
		Primary Drinking Water Standards ^{1, 2}	Human Health Screening Value ³				Analytical Method - SOM01.2 Low Water by SIM	Analytical Method - SOM01.2 Low Water		
N-Nitrosodiphenylamine	86-30-6	NL	14	14	5	N/A	NL	5	N/A	N/A
Pentachlorophenol	87-86-5	1	0.56	0.56	0.2	N/A	0.2	10	N/A	N/A
Phenanthrene	85-01-8	NL	1100	1100	220	N/A	0.1	5	N/A	N/A
Phenol	108-95-2	NL	1100	1100	220	N/A	NL	5	N/A	N/A
Pyrene	129-00-0	NL	110	110	22	N/A	0.1	5	N/A	N/A

Notes:

1. EPA National Primary Drinking Water Standards (web page <http://www.epa.gov/safewater/contaminants/index.html>), EPA 816-F-03-016, June 2003. last updated November 28, 2006.
 2. Puerto Rico Groundwater Quality Standards (PRGQS) Regulation, As Amended. March 28, 2003.
Received from Puerto Rico Environmental Quality Board
 3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
Screening value for acenaphthene applied to acenaphthylene.
Screening value for pyrene applied to benzo(g,h,i)perylene.
Screening value for anthracene applied to phenanthrene.
 4. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
- ^ - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not Applicable
NL = Not Listed or chemical name listed but no value available

QAPP Worksheet #15c

Reference Limits and Evaluation Table - Groundwater Pesticides

Pesticides	CAS Number	Criteria		Project Action Limit (µg/L)	Project Quantitation Limit Goal (µg/L) ⁷	Analytical Method ⁴			Achievable Laboratory Limits	
		Primary Drinking Water Standards ^{1,2}	Human Health Screening Value ³			MDLs	CRQLs µg/L	Option	MDLs	QLs
4,4'-DDD	72-54-8	NL	0.28	0.28	0.1	N/A	0.1	Low	N/A	N/A
4,4'-DDE	72-55-9	NL	0.2	0.2	0.1	N/A	0.1	Low	N/A	N/A
4,4'-DDT	50-29-3	NL	0.2	0.2	0.1	N/A	0.1	Low	N/A	N/A
Aldrin	309-00-2	NL	0.004	0.004	0.004	N/A	0.05	Low	N/A	N/A
alpha-BHC	319-84-6	NL	0.011	0.011	0.011	N/A	0.05	Low	N/A	N/A
alpha-Chlordane ⁵	5103-71-9	0.2	0.19	0.19	0.05	N/A	0.05	Low	N/A	N/A
beta-BHC	319-85-7	NL	0.037	0.037	0.037	N/A	0.05	Low	N/A	N/A
delta-BHC	319-86-8	NL	NL	NL	NL	N/A	0.1	Low	N/A	N/A
Dieldrin	60-57-1	NL	0.0042	0.0042	0.0042	N/A	0.1	Low	N/A	N/A
Endosulfan I ⁶	959-98-8	0.056	22	0.056	0.05	N/A	0.05	Low	N/A	N/A
Endosulfan II ⁶	33213-65-9	0.056	22	0.056	0.056	N/A	0.1	Low	N/A	N/A
Endosulfan sulfate	1031-07-8	NL	NL	NL	0.1	N/A	0.1	Low	N/A	N/A
Endrin	72-20-8	0.0023	1.1	0.0023	0.0023	N/A	0.1	Low	N/A	N/A
Endrin aldehyde	7421-93-4	NL	NL	NL	NL	N/A	0.1	Low	N/A	N/A
Endrin ketone	53494-70-5	NL	NL	NL	NL	N/A	0.1	Low	N/A	N/A
gamma-BHC (Lindane)	58-89-9	0.2	0.061	0.061	0.061	N/A	0.1	Low	N/A	N/A
gamma-Chlordane ⁵	5103-74-2	0.2	0.19	0.19	0.038	N/A	0.1	Low	N/A	N/A
Heptachlor	76-44-8	0.4	0.015	0.015	0.015	N/A	0.1	Low	N/A	N/A
Heptachlor epoxide	1024-57-3	0.2	0.0074	0.0074	0.0074	N/A	0.1	Low	N/A	N/A
Methoxychlor	72-43-5	3	18	3	0.6	N/A	0.5	Low	N/A	N/A
Toxaphene	8001-35-2	3	0.061	0.061	0.061	N/A	5	Low	N/A	N/A

QAPP Worksheet #15c
Reference Limits and Evaluation Table - Groundwater Pesticides

Notes

1. EPA National Primary Drinking Water Standards (NPDWS) (web page), EPA 816-F-03-016 June 2003.
 2. Puerto Rico Groundwater Quality Standards (PRGQS) Regulation, As Amended. March 28, 2003.
Received from Puerto Rico Environmental Quality Board also located at: <http://www.epa.gov/ost/standards/wqslibrary/pr/pr.html>
also located at: <http://www.epa.gov/ost/standards/wqslibrary/pr/pr.html>
 3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
The criteria used for the Project Action Limit is the lower value of 1. , 2. and 3.
 4. SOM01.2 Low Water Option.
 5. Criteria limits shown for alpha - chlordane and gamma-chlordane is actually for total chlordane.
 6. Human health criteria limit shown is actually for Endosulfan which is used here as a surrogate for Endosulfan I and Endosulfan II.
 7. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
- ^ - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

CRQL - Contract Required Quantitation Limit	NA - Not Applicable	µg/L - microgram per liter
MDL - Method detection limit	NL - Chemical name not listed or screening value of this type not listed for the chemical	

QAPP Worksheet #15d
Reference Limits and Evaluation Table - Groundwater PCBs

PCBs	CAS Number	Criteria		Project Action Limit (µg/L)	Project Quantitation Limit Goal (µg/L) ⁵	Analytical Method ⁴			Achievable Laboratory Limits	
		Primary Drinking Water Standards ^{1, 2}	Human Health Screening Value ³			MDLs	CRQLs µg/L	Option	MDLs	QLs
Aroclor-1016	12674-11-2	0.5	0.96	0.5	0.5	N/A	1	Low	N/A	N/A
Aroclor-1221	11104-28-2	0.5	0.0068	0.0068	0.0068	N/A	1	Low	N/A	N/A
Aroclor-1232	11141-16-5	0.5	0.0068	0.0068	0.0068	N/A	1	Low	N/A	N/A
Aroclor-1242	53469-21-9	0.5	0.034	0.034	0.034	N/A	1	Low	N/A	N/A
Aroclor-1248	12672-29-6	0.5	0.034	0.034	0.034	N/A	1	Low	N/A	N/A
Aroclor-1254	11097-69-1	0.5	0.034	0.034	0.034	N/A	1	Low	N/A	N/A
Aroclor-1260	11096-82-5	0.5	0.034	0.034	0.034	N/A	1	Low	N/A	N/A

Notes

1. EPA National Primary Drinking Water Standards (NPDWS) (web page), EPA 816-F-03-016 June 2003.

2. Puerto Rico Groundwater Quality Standards (PRGQS) Regulation, As Amended. March 28, 2003.

Received from Puerto Rico Environmental Quality Board also located at: <http://www.epa.gov/ost/standards/wqslibrary/pr/pr.html>

also located at: <http://www.epa.gov/ost/standards/wqslibrary/pr/pr.html>

3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.

The criteria used for the Project Action Limit is the lower value of 1. , 2. and 3.

4. SOM01.2 Low Water Option.

5. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.

[^] - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

CRQL - Contract Required Quantitation Limit

MDL - Method detection limit

NA - Not Applicable

NL - Chemical name not listed or screening value of this type not listed for the chemical

µg/L - microgram per liter

QAPP Worksheet #15e
Reference Limits and Evaluation Table - Groundwater Inorganics

Inorganics^ (All units: µg/L)	CAS Number	Criteria		Project Action Limit (PAL)	Project Quantitation Limit Goal (PQLG) ⁴	Analytical Method			Achievable Laboratory Limits	
		Federal/ Commonwealth	Risk Assessment			MDLs	CRQL	Analytical Method - ILM05.4	MDLs	QLs
		Primary Drinking Water Standards ^{1,2}	Human Health Screening Value ³							
Aluminum	7429-90-5	NL	3,700	3,700	740	N/A	200	ICP-AES	N/A	N/A
Antimony	7440-36-0	6	1.5	1.5	1.5	N/A	2	ICP-MS	N/A	N/A
Arsenic	7440-38-2	10	0.045	0.045	0.05	N/A	1	ICP-MS	N/A	N/A
Barium	7440-39-3	2000	730	730	146	N/A	10	ICP-MS	N/A	N/A
Beryllium	7440-41-7	4	7.3	4	1	N/A	1	ICP-MS	N/A	N/A
Cadmium	7440-43-9	5	1.8	1.8	1	N/A	1	ICP-MS	N/A	N/A
Calcium	7440-70-2	NL	NL	NL	NL	N/A	5000	ICP-AES	N/A	N/A
Chromium	7440-47-3	100	11	11	10	N/A	2	ICP-MS	N/A	N/A
Cobalt	7440-48-4	NL	1	1	1	N/A	1	ICP-MS	N/A	N/A
Copper	7440-50-8	1300	150	150	30	N/A	2	ICP-MS	N/A	N/A
Cyanide	57-12-5	200	73	73	14.6	N/A	10	ICP-AES	N/A	N/A
Iron	7439-89-6	NL	2,600	2,600	100	N/A	100	ICP-AES	N/A	N/A
Lead	7439-92-1	15	NL	15	10	N/A	1	ICP-MS	N/A	N/A
Magnesium	7439-95-4	NL	NL	NL	NL	N/A	5000	ICP-AES	N/A	N/A
Manganese	7439-96-5	NL	88	88	17.6	N/A	1	ICP-MS	N/A	N/A
Mercury	7439-97-6	2	1.1	1	0.2	N/A	0.2	ICP-AES	N/A	N/A
Nickel	7440-02-0	NL	73	73	40	N/A	1	ICP-MS	N/A	N/A
Potassium	7440-09-7	NL	NL	NL	NL	N/A	5000	ICP-AES	N/A	N/A
Selenium	7782-49-2	50	18	18	5	N/A	5	ICP-MS	N/A	N/A
Silver	7440-22-4	NL	18	18	10	N/A	1	ICP-MS	N/A	N/A
Sodium	7440-23-5	NL	NL	NL	NL	N/A	5000	ICP-AES	N/A	N/A
Thallium	7440-28-0	2	0.24	0.24	0.24	N/A	1	ICP-MS	N/A	N/A
Vanadium	7440-62-2	NL	18	18	5	N/A	5	ICP-MS	N/A	N/A
Zinc	7440-66-6	NL	1,100	1,100	220	N/A	2	ICP-MS	N/A	N/A

QAPP Worksheet #15e

Reference Limits and Evaluation Table - Groundwater Inorganics

Notes:

1. EPA National Primary Drinking Water Standards (web page <http://www.epa.gov/safewater/contaminants/index.html>), EPA 816-F-03-016, June 2003. last updated November 28, 2006.
 2. Puerto Rico Groundwater Quality Standards (PRGQS) Regulation, As Amended. March 28, 2003.
Received from Puerto Rico Environmental Quality Board
 3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
There is no RSL for total chromium. Screening value for chromium (VI) applied to chromium.
Screening value for vanadium and compounds is used for vanadium.
Screening value for mercury (inorganic salts) is used for mercury.
 4. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
- ^ - The compounds are bolded if the ILM05.4 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

AES = atomic emission spectroscopy

CLP = Contract Laboratory Program

CRQL = Contract Required Quantitation Limit

EPA = United States Environmental Protection Agency

MDL = method detection limit

TOGS = Technical and Operational Guidance Series

µg/L = microgram per liter

QAPP Worksheet #15f
Reference Limits and Evaluation Table
Groundwater & Surface Water Quality Compounds

Compounds	CAS Number	Project Action Limit ¹ (mg/L)	Project Quantitation Limit Goal (mg/L)	Analytical Method		Achievable Laboratory	
				MDLs ²	Typical Quantitation Limits (mg/L)	MDLs	QLs
Ammonia	N/A	2	0.05	N/A	0.02 - 0.05	TBD	TBD
TDS	N/A	1	0.01	N/A	0.01	TBD	TBD
Hardness	N/A	NL	1	N/A	1	TBD	TBD
Chloride	N/A	250	1	N/A	0.05 - 1	TBD	TBD
Nitrate	N/A	10	0.1	N/A	0.1	TBD	TBD
Nitrite	N/A	1	0.1	N/A	0.01 - 0.1	TBD	TBD
Sulfate	N/A	250	0.03	N/A	0.03	TBD	TBD
Sulfide	N/A	0.002*	0.002	N/A	1	TBD	TBD
TOC	N/A	NL	1.0	N/A	1	TBD	TBD
TSS	N/A	NL	0.004	N/A	0.004	TBD	TBD
TKN	N/A	NL	0.1	N/A	0.1 - 0.3	TBD	TBD
MEE	N/A	NL	0.01	N/A	0.01	TBD	TBD
Ferrous Iron	N/A	NL	NL	N/A	NL	TBD	TBD

Notes

1. NYSDEC. June 1998. TOGS 1.1.1. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. Includes April 2000 and June 2004 Addendum values. (<http://www.dec.ny.gov/regulations/2652.html>).

* - Expressed as hydrogen sulfide

2. MDLs are not defined in these methods. The DESA request or laboratory SOW will include the PQLGs in order to achieve the requested limits.

Acronyms:

CAS = Chemical Abstract Service

mg/L = milligrams per Liter

MDLs = method detection limits

QLs = quantitation limits

TDS = total dissolved solids

TSS = total suspended solids

TKN = total kjedhal nitrogen

MEE = methane, ethane, ethene

N/A = not available

NL = not listed

TBD = to be determined

QAPP Worksheet #15g
Reference Limits and Evaluation Table - Surface Water VOCs

Volatile Organic Compounds (VOCs)^ (All units: µg/L)	CAS Number	Federal and State Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁵	Analytical Method ⁴			Achievable Laboratory Limits	
		Federal & State Criteria 1,2	Human Health Screening Value ³			MDLs	CRQL		MDLs	QLs
							Analytical Method - SOM01.2 Trace Water by SIM	Analytical Method - SOM01.2 Trace Water		
1,1,1-Trichloroethane	71-55-6	200	910	200	40	N/A	NL	0.5	N/A	N/A
1,1,2,2-Tetrachloroethane	79-34-5	1.7	0.067	0.067	0.067	N/A	NL	0.5	N/A	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	5,900	5,900	1,180	N/A	NL	0.5	N/A	N/A
1,1,2-Trichloroethane	79-00-5	6	0.24	0.24	0.24	N/A	NL	0.5	N/A	N/A
1,1-Dichloroethane	75-34-3	0.38	2.4	0.38	0.38	N/A	NL	0.5	N/A	N/A
1,1-Dichloroethene	75-35-4	0.57	34	0.57	0.57	N/A	NL	0.5	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	NL	NL	NL	NL	N/A	NL	0.5	N/A	N/A
1,2,4-Trichlorobenzene	120-82-1	260	0.82	0.82	0.50	N/A	NL	0.5	N/A	N/A
1,2-Dibromo-3-chloropropane	96-12-8	NL	0.00032	0.00032	0.00032	N/A	0.05	0.5	N/A	N/A
1,2-Dibromoethane	106-93-4	NL	0.0065	0.0065	0.0065	N/A	0.05	0.5	N/A	N/A
1,2-Dichlorobenzene	95-50-1	420	37	37	7.40	N/A	NL	0.5	N/A	N/A
1-2-Dichloroethane	107-06-2	3.8	0.15	0.15	0.15	N/A	NL	0.5	N/A	N/A
1,2-Dichloropropane	78-87-5	5.2	0.39	0.39	0.39	N/A	NL	0.5	N/A	N/A
1,3-Dichlorobenzene	541-73-1	400	NL	400	80.00	N/A	NL	0.5	N/A	N/A
1,4-Dichlorobenzene	106-46-7	400	0.43	0.43	0.43	N/A	NL	0.5	N/A	N/A
2-Butanone	78-93-3	NL	710	710	142	N/A	NL	5	N/A	N/A
2-Hexanone	591-78-6	NL	NL	NL	NL	N/A	NL	5	N/A	N/A
4-Methyl-2-pentanone	108-10-1	NL	200	200	40	N/A	NL	5	N/A	N/A
Acetone	67-64-1	NL	2,200	2,200	440	N/A	NL	5	N/A	N/A
Benzene	71-43-2	12	0.41	0.41	0.41	N/A	NL	0.5	N/A	N/A
Bromochloromethane	74-97-5	NL	NL	NL	NL	N/A	NL	0.5	N/A	N/A
Bromodichloromethane	75-27-4	0.55	1.1	0.55	0.55	N/A	NL	0.5	N/A	N/A
Bromoform	75-25-2	43	8.5	8.5	1.70	N/A	NL	0.5	N/A	N/A
Bromomethane	74-83-9	NL	0.87	0.87	0.50	N/A	NL	0.5	N/A	N/A
Carbon Disulfide	75-15-0	0.23	100	0.23	0.23	N/A	NL	0.5	N/A	N/A
Carbon Tetrachloride	56-23-5	2.5	0.2	0.2	0.2	N/A	NL	0.5	N/A	N/A

QAPP Worksheet #15g
Reference Limits and Evaluation Table - Surface Water VOCs

Volatile Organic Compounds (VOCs)^ (All units: µg/L)	CAS Number	Federal and State Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁵	Analytical Method ⁴			Achievable Laboratory Limits	
		Federal & State Criteria 1,2	Human Health Screening Value ³			MDLs	CRQL		MDLs	QLs
							Analytical Method - SOM01.2 Trace Water by SIM	Analytical Method - SOM01.2 Trace Water		
Chlorobenzene	108-90-7	680	9.1	9.1	1.82	N/A	NL	0.5	N/A	N/A
Chloroethane	75-00-3	NL	2,100	2,100	420	N/A	NL	0.5	N/A	N/A
Chloroform	67-66-3	57	0.19	0.19	0.19	N/A	NL	0.5	N/A	N/A
Chloromethane	74-87-3	NL	1.8	1.8	1.0	N/A	NL	0.5	N/A	N/A
cis-1,2-Dichloroethene	540-59-0	NL	37	37	7.4	N/A	NL	0.5	N/A	N/A
cis-1,3-Dichloropropene	26952-23-8	0.34	NL	0.34	0.34	N/A	NL	0.5	N/A	N/A
Cyclohexane	110-82-7	NL	1,300	1,300	260	N/A	NL	0.5	N/A	N/A
Dibromochloromethane	124-48-1	5.6	0.8	0.8	0.50	N/A	NL	0.5	N/A	N/A
Dichlorodifluoromethane	75-71-8	NL	39	39	7.8	N/A	NL	0.5	N/A	N/A
Ethylbenzene	100-41-4	3100	1.5	1.5	1.0	N/A	NL	0.5	N/A	N/A
Isopropylbenzene	98-82-8	NL	68	68	13.60	N/A	NL	0.5	N/A	N/A
Methyl acetate	79-20-9	NL	3,700	3,700	740	N/A	NL	0.5	N/A	N/A
Methyl tertiary butyl ether	1634-04-4	NL	12	12	2.40	N/A	NL	0.5	N/A	N/A
Methylcyclohexane	108-87-2	NL	NL	NL	NL	N/A	NL	0.5	N/A	N/A
Methylene Chloride	75-09-2	470	4.8	4.8	0.96	N/A	NL	0.5	N/A	N/A
m,p-Xylene	1330-20-7	NL	20	20	4.00	N/A	NL	0.5	N/A	N/A
o-Xylene	1330-20-7	NL	20	20	4.00	N/A	NL	0.5	N/A	N/A
p-Xylene	1330-20-7	NL	NL	NL	NL	N/A	NL	0.5	N/A	N/A
Styrene	100-42-5	100	160	160	32.0	N/A	NL	0.5	N/A	N/A
Tetrachloroethene	127-18-4	0.69	0.11	0.11	0.11	N/A	NL	0.5	N/A	N/A
Toluene	108-88-3	1300	230	230	46	N/A	NL	0.5	N/A	N/A
trans-1,2-Dichloroethene	156-60-5	140	11	11	2.20	N/A	NL	0.5	N/A	N/A
trans-1,3-Dichloropropene	10061-02-6	0.34	NL	0.34	0.34	N/A	NL	0.5	N/A	N/A
Trichloroethene	79-01-6	2.5	1.7	1.7	1.0	N/A	NL	0.5	N/A	N/A

QAPP Worksheet #15g
Reference Limits and Evaluation Table - Surface Water VOCs

Volatile Organic Compounds (VOCs)^ (All units: µg/L)	CAS Number	Federal and State Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁵	Analytical Method ⁴			Achievable Laboratory Limits	
		Federal & State Criteria 1,2	Human Health Screening Value ³			MDLs	CRQL		MDLs	QLs
							Analytical Method - SOM01.2 Trace Water by SIM	Analytical Method - SOM01.2 Trace Water		
Trichlorofluoromethane	75-69-4	NL	130	130	26	N/A	NL	0.5	N/A	N/A
Vinyl Chloride	75-01-4	2	0.016	0.016	0.016	N/A	NL	0.5	N/A	N/A
Xylenes (total)	1330-20-7	NL	NL	NL	NL	N/A	NL	0.5	N/A	N/A

Notes:

1. NRWQC - USEPA. 2004. National Recommended Water Quality Criteria. United States Environmental Protection Agency Office of Water, Office of Science and Technology.
 2. PRWQS - PREQB. 2003. Puerto Rico Water Quality Standards Regulation, as Amended on March 2003. Commonwealth of Puerto Rico Office of the Governor Environmental Quality Board, Law No. 9 of June 18, 1970. Priority is given to PRWQS.
 3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
 4. SOM01.2 Soil Method
 5. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
- [^] - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not Applicable
NRWQC = National Recommended Water Quality Criteria

NL = Not Listed or chemical name listed but no value available
PREQB = Puerto Rico Environmental Quality Board
PRWQS = Puerto Rico Water Quality Standards
PAL= Project Action Limit
µg/L = microgram per liter

QAPP Worksheet #15h
Reference Limits and Evaluation Table - Surface Water SVOCs

Semi-Volatile Organic Compounds (SVOCs) ^A (All units: µg/L)	CAS Number	Federal and State Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁴	Analytical Method			Achievable Laboratory Limits	
		Federal & State Criteria ^{1,2}	Human Health Screening Value ²			MDLs	CRQLs	Level	MDLs	QLs
1,1'Biphenyl	92-52-4	NL	180	180	36	N/A	5	Low	N/A	N/A
2,2'-oxybis(1-Chloropropane)	108-60-1	NL	0.32	0.32	0.32	N/A	5	Low	N/A	N/A
2,4,-Trichlorophenol	95-95-4	NL	370	370	74	N/A	5	Low	N/A	N/A
2,4,6-Trichlorophenol	88-06-2	1.4	6.1	1.4	1.4	N/A	5	Low	N/A	N/A
2,4-Dichlorophenol	120-83-2	77	11	11	5	N/A	5	Low	N/A	N/A
2,4-Dimethylphenol	105-67-9	380	73	73	14.6	N/A	5	Low	N/A	N/A
2,4-Dinitrophenol	51-28-5	69	7.3	7.3	7.3	N/A	10	Low	N/A	N/A
2,4-Dinitrotoluene	121-14-2	0.11	7.3	0.11	0.11	N/A	5	Low	N/A	N/A
2,6-Dinitrotoluene	606-20-2	NL	3.7	3.7	3.7	N/A	5	Low	N/A	N/A
2-Chloronaphthalene	91-58-7	1700	290	290	58	N/A	5	Low	N/A	N/A
2-Chlorophenol	95-57-8	81	18	18	5	N/A	5	Low	N/A	N/A
2-Methylnaphthalene	91-57-6	NL	15	15	5	N/A	5	Low	N/A	N/A
2-Methylphenol	95-48-7	NL	180	180	36	N/A	5	Low	N/A	N/A
2-Nitroaniline	88-74-4	NL	11	11	5	N/A	5	Low	N/A	N/A
2-Nitrophenol	88-75-5	NL	NL	NL	NL	N/A	5	Low	N/A	N/A
3,3'-Dichlorobenzidine	91-94-1	0.4	0.15	0.15	0.021	N/A	5	Low	N/A	N/A
3-Nitroaniline	99-09-2	NL	3.2	3.2	3.2	N/A	10	Low	N/A	N/A
4,6-Dinitro-2-methylphenol	534-52-1	NL	0.37	0.37	0.37	N/A	10	Low	N/A	N/A
4-Bromophenyl-phenylether	101-55-3	NL	NL	NL	NL	N/A	5	Low	N/A	N/A
4-Chloro-3-methylphenol	59-50-7	NL	NL	NL	NL	N/A	5	Low	N/A	N/A
4-Chloroaniline	106-47-8	NL	1.2	1.2	1.2	N/A	5	Low	N/A	N/A
4-Chlorophenyl-phenylether	7005-72-3	NL	NL	NL	NL	N/A	5	Low	N/A	N/A
4-Methylphenol	106-44-5	NL	18	18	5	N/A	5	Low	N/A	N/A
4-Nitroaniline	100-01-6	NL	3.2	3.2	3.2	N/A	10	Low	N/A	N/A
4-Nitrophenol	100-02-7	NL	NL	NL	NL	N/A	10	Low	N/A	N/A
Acenaphthene	83-32-9	1200	220	220	44	N/A	5	Low	N/A	N/A
Acenaphthylene	208-96-8	NL	220	220	44	N/A	5	Low	N/A	N/A
Acetophenone	98-86-2	NL	370	370	74	N/A	5	Low	N/A	N/A
Anthracene	120-12-7	8300	1100	1100	220	N/A	5	Low	N/A	N/A

QAPP Worksheet #15h
Reference Limits and Evaluation Table - Surface Water SVOCs

Semi-Volatile Organic Compounds (SVOCs) ^A (All units: µg/L)	CAS Number	Federal and State Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁴	Analytical Method			Achievable Laboratory Limits	
		Federal & State Criteria ^{1,2}	Human Health Screening Value ²			MDLs	CRQLs	Level	MDLs	QLs
Atrazine	1912-24-9	3	0.29	0.29	0.29	N/A	0.1	SIM	N/A	N/A
Benzaldehyde	100-52-7	NL	370	370	74	N/A	5	Low	N/A	N/A
Benzo(a)anthracene	56-55-3	0.044	0.029	0.029	0.029	N/A	0.1	SIM	N/A	N/A
Benzo(a)pyrene	50-32-8	0.044	0.0029	0.0029	0.0029	N/A	0.1	SIM	N/A	N/A
Benzo(b)fluoranthene	205-99-2	0.044	0.029	0.029	0.029	N/A	0.1	SIM	N/A	N/A
Benzo(g,h,i)perylene	191-24-2	NL	110	110	22	N/A	5	Low	N/A	N/A
Benzo(k)fluoranthene	207-08-9	0.044	0.29	0.044	0.044	N/A	0.1	SIM	N/A	N/A
bis(2-Chloroethoxy)methane	111-91-1	NL	11	11	5	N/A	5	Low	N/A	N/A
bis(2-Chloroethyl)ether	111-44-4	0.31	0.012	0.012	0.012	N/A	5	Low	N/A	N/A
bis(2-Ethylhexyl)phthalate	117-81-7	18	4.8	4.8	4.8	N/A	5	Low	N/A	N/A
Butylbenzylphthalate	85-68-7	3000	35	35	7	N/A	5	Low	N/A	N/A
Caprolactam	105-60-2	NL	1,800	1,800	360	N/A	5	Low	N/A	N/A
Carbazole	86-74-8	NL	NL	NL	NL	N/A	5	Low	N/A	N/A
Chrysene	218-01-9	0.044	2.9	0.044	0.0038	N/A	0.1	SIM	N/A	N/A
Dibenz(a,h)anthracene	53-70-3	0.044	0.0029	0.0029	0.0038	N/A	0.1	SIM	N/A	N/A
Dibenzofuran	132-64-9	NL	NL	NL	NL	N/A	5	Low	N/A	N/A
Diethylphthalate	84-66-2	23000	2900	2900	580	N/A	5	Low	N/A	N/A
Dimethylphthalate	131-11-3	313000	NL	313,000	62,600	N/A	5	Low	N/A	N/A
Di-n-butylphthalate	84-74-2	2700	370	370	74	N/A	5	Low	N/A	N/A
Di-n-octyl phthalate	117-84-0	NL	NL	NL	NL	N/A	5	Low	N/A	N/A
Fluoranthene	206-44-0	300	150	150	30	N/A	5	Low	N/A	N/A
Fluorene	86-73-7	1300	150	150	30	N/A	5	Low	N/A	N/A
Hexachlorobenzene	118-74-1	0.0075	0.042	0.0075	0.0075	N/A	5	Low	N/A	N/A
Hexachlorobutadiene	87-68-3	4.4	0.86	0.86	0.86	N/A	5	Low	N/A	N/A
Hexachlorocyclopentadiene	77-47-4	240	22	22	5	N/A	5	Low	N/A	N/A
Hexachloroethane	67-72-1	19	4.8	4.8	4.8	N/A	5	Low	N/A	N/A
Indeno(1,2,3-cd)pyrene	193-39-5	0.044	0.029	0.029	0.029	N/A	0.1	SIM	N/A	N/A
Isophorone	78-59-1	360	71	71	14.2	N/A	5	Low	N/A	N/A
Naphthalene	91-20-3	NL	0.14	0.14	0.14	N/A	0.1	SIM	N/A	N/A
Nitrobenzene	98-95-3	17	0.34	0.34	0.34	N/A	5	Low	N/A	N/A

QAPP Worksheet #15h
Reference Limits and Evaluation Table - Surface Water SVOCs

Semi-Volatile Organic Compounds (SVOCs) [^] (All units: µg/L)	CAS Number	Federal and State Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁴	Analytical Method			Achievable Laboratory Limits	
		Federal & State Criteria ^{1,2}	Human Health Screening Value ²			MDLs	CRQLs	Level	MDLs	QLs
N-Nitroso-di-n-propylamine	621-64-7	0.05	0.0096	0.0096	0.0096	N/A	5	Low	N/A	N/A
N-Nitrosodiphenylamine	86-30-6	50	14	14	5	N/A	5	Low	N/A	N/A
Pentachlorophenol	87-86-5	NL	0.56	0.56	0.56	N/A	0.2	SIM	N/A	N/A
Phenanthrene	85-01-8	NL	1100	1100	220	N/A	5	Low	N/A	N/A
Phenol	108-95-2	NL	1100	1100	220	N/A	5	Low	N/A	N/A
Pyrene	129-00-0	960	110	110	22	N/A	5	Low	N/A	N/A

Notes:

1. NRWQC - USEPA. 2004. National Recommended Water Quality Criteria. United States Environmental Protection Agency Office of Water, Office of Science and Technology.
 2. PRWQS - PREQB. 2003. Puerto Rico Water Quality Standards Regulation, as Amended on March 2003. Commonwealth of Puerto Rico Office of the Governor Environmental Quality Board, Law No. 9 of June 18, 1970. Priority is given to PRWQS.
 3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
Screening value for acenaphthene applied to acenaphthylene.
Screening value for pyrene applied to benzo(g,h,i)perylene.
Screening value for anthracene applied to phenanthrene.
 4. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%.
If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
- [^] - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not Applicable
NRWQC = National Recommended Water Quality Criteria

NL = Not Listed or chemical name listed but no value available
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PRWQS = Puerto Rico Water Quality Standards
PAL= Project Action Limit
µg/L = microgram per liter

QAPP Worksheet # 15i
Reference Limits and Evaluation Table - Surface Water Pesticides

Pesticides	CAS Number	Federal and State Criteria		Project Action Limit (µg/L)	Project Quantitation Limit Goal (µg/L)	Analytical Method ⁴		Achievable Laboratory Limits	
		Federal & State Criteria ^{1,2}	Human Health Screening Value ³			MDLs	CRQLs (µg/L)	MDLs	QLs
4,4'-DDD	72-54-8	0.001	0.28	0.001	0.001	N/A	0.1	N/A	N/A
4,4'-DDE	72-55-9	0.001	0.2	0.001	0.001	N/A	0.1	N/A	N/A
4,4'-DDT	50-29-3	0.001	0.2	0.001	0.001	N/A	0.1	N/A	N/A
Aldrin	309-00-2	0.0013	0.004	0.0013	0.0013	N/A	0.05	N/A	N/A
alpha-BHC	319-84-6	0.000049	0.011	0.000049	0.000049	N/A	0.05	N/A	N/A
alpha-Chlordane	5103-71-9	0.0043	0.19	0.0043	0.0043	N/A	0.05	N/A	N/A
beta-BHC	319-85-7	0.0091	0.037	0.0091	0.0091	N/A	0.05	N/A	N/A
delta-BHC	319-86-8	NL	NL	NL	NL	N/A	0.05	N/A	N/A
Dieldrin	60-57-1	0.0014	0.0042	0.0014	0.0014	N/A	0.1	N/A	N/A
Endosulfan I	959-98-8	0.056	22	0.056	0.05	N/A	0.05	N/A	N/A
Endosulfan II	33213-65-9	0.056	22	0.056	0.056	N/A	0.1	N/A	N/A
Endosulfan sulfate	1031-07-8	62	NL	62	12.4	N/A	0.1	N/A	N/A
Endrin	72-20-8	0.036	1.1	0.036	0.036	N/A	0.1	N/A	N/A
Endrin aldehyde	7421-93-4	0.29	NL	0.29	0.1	N/A	0.1	N/A	N/A
Endrin ketone	53494-70-5	NL	NL	NL	NL	N/A	0.1	N/A	N/A
gamma-BHC (Lindane)	58-89-9	0.19	0.061	0.061	0.05	N/A	0.05	N/A	N/A
gamma-Chlordane	5103-74-2	0.0043	0.19	0.0043	0.0043	N/A	0.05	N/A	N/A
Heptachlor	76-44-8	0.0021	0.015	0.0021	0.0021	N/A	0.05	N/A	N/A
Heptachlor epoxide	1024-57-3	0.0038	0.0074	0.0038	0.0038	N/A	0.05	N/A	N/A
Methoxychlor	72-43-5	0.03	18	0.03	0.03	N/A	0.5	N/A	N/A
Toxaphene	8001-35-2	0.0002	0.061	0.0002	0.0002	N/A	5	N/A	N/A

Notes:

1. NRWQC - USEPA. 2004. National Recommended Water Quality Criteria. United States Environmental Protection Agency Office of Water, Office of Science and Technology.

2. PRWQS - PREQB. 2003. Puerto Rico Water Quality Standards Regulation, as Amended on March 2003.
Commonwealth of Puerto Rico Office of the Governor Environmental Quality Board, Law No. 9 of June 18, 1970.
Priority is given to PRWQS.

3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.

The criteria used for the Project Action Limit is the lower value of 1., 2. and 3.

4. SOM01.2 most CRQLs are above the PQLGs. A contract modification will be requested to achieve the project goal where possible.

5. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.

^ - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

EPA = United States Environmental Protection Agency
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PAL= Project Action Limit
µg/L = microgram per liter

QAPP Worksheet # 15j
Reference Limits and Evaluation Table - Surface Water PCBs

PCBs	CAS Number	Federal and State Criteria		Project Action Limit (µg/L)	Project Quantitation Limit Goal (µg/L)	Analytical Method ⁵		Achievable Laboratory Limits ²	
		Federal & State Criteria ^{1,2}	Human Health Screening Value ³			MDLs	CRQLs (µg/L)	MDLs	QLs
Aroclor-1016	12674-11-2	0.014	0.96	0.014	0.014	N/A	1	N/A	N/A
Aroclor-1221	11104-28-2	0.014	0.0068	0.0068	0.0068	N/A	1	N/A	N/A
Aroclor-1232	11141-16-5	0.014	0.0068	0.0068	0.0068	N/A	1	N/A	N/A
Aroclor-1242	53469-21-9	0.014	0.034	0.014	0.014	N/A	1	N/A	N/A
Aroclor-1248	12672-29-6	0.014	0.034	0.014	0.014	N/A	1	N/A	N/A
Aroclor-1254	11097-69-1	0.014	0.034	0.014	0.014	N/A	1	N/A	N/A
Aroclor-1260	11096-82-5	0.014	0.034	0.014	0.014	N/A	1	N/A	N/A

Notes:

1. NRWQC - USEPA. 2004. National Recommended Water Quality Criteria. United States Environmental Protection Agency Office of Water, Office of Science and Technology.
 2. PRWQS - PREQB. 2003. Puerto Rico Water Quality Standards Regulation, as Amended on March 2003. Commonwealth of Puerto Rico Office of the Governor Environmental Quality Board, Law No. 9 of June 18, 1970. Priority is given to PRWQS.
 3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
The criteria used for the Project Action Limit is the lower value of 1., 2. and 3.
 4. SOM01.2 most CRQLs are above the PQLGs. A contract modification will be requested to achieve the project goal where possible.
 5. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
- ^ - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Acronyms:

EPA = United States Environmental Protection Agency
CAS = Chemical abstract service
CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not Applicable
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QAPP Worksheet # 15k
Reference Limits and Evaluation Table - Surface Water Inorganics

Inorganic Analytes [^] (All units: µg/L)	CAS Number	Federal and State Criteria		PAL	Project Quantitation Limit Goal (PQLG) ⁵	Analytical Method ⁴			Achievable Laboratory Limits	
		Federal & State Criteria ^{1,2}	Human Health Screening Value ³			MDLs	CRQLs	Method	MDLs	QLs
Aluminum	7429-90-5	87	3,700	87	87	N/A	200	ICP-AES	N/A	N/A
Antimony	7440-36-0	14	2	2	2	N/A	2	ICP-MS	N/A	N/A
Arsenic	7440-38-2	0.18	0.05	0.05	0.05	N/A	1	ICP-MS	N/A	N/A
Barium	7440-39-3	NL	730	730	146	N/A	10	ICP-MS	N/A	N/A
Beryllium	7440-41-7	NL	7	7	1.46	N/A	1	ICP-MS	N/A	N/A
Cadmium	7440-43-9	0.25	2	0.25	0.25	N/A	1	ICP-MS	N/A	N/A
Calcium	7440-70-2	NL	NL	NL	NL	N/A	5,000	ICP-AES	N/A	N/A
Chromium	7440-47-3	11	11	11	2.2	N/A	2	ICP-MS	N/A	N/A
Cobalt	7440-48-4	NL	1	1	1	N/A	5	ICP-MS	N/A	N/A
Copper	7440-50-8	9	150	9	2	N/A	2	ICP-AES	N/A	N/A
Cyanide	57-12-5	5.2	73	5.2	5.2	N/A	10	ICP-AES	N/A	N/A
Iron	7439-89-6	1000	2,600	1,000	200	N/A	100	ICP-AES	N/A	N/A
Lead	7439-92-1	15	15	15	3	N/A	1	ICP-MS	N/A	N/A
Magnesium	7439-95-4	NL	NL	NL	NL	N/A	5,000	ICP-AES	N/A	N/A
Manganese	7439-96-5	NL	88	88	17.6	N/A	15	ICP-AES	N/A	N/A
Mercury	7439-97-6	0.05	0.057	0.050	0.050	N/A	0.2	ICP-AES	N/A	N/A
Nickel	7440-02-0	52	73	52	40	N/A	40	ICP-AES	N/A	N/A
Potassium	7440-09-7	NL	NL	NL	NL	N/A	5,000	ICP-AES	N/A	N/A
Selenium	7782-49-2	5	18	5	5	N/A	5	ICP-MS	N/A	N/A
Silver	7440-22-4	3.2	18	3.2	1	N/A	1	ICP-MS	N/A	N/A
Sodium	7440-23-5	NL	NL	NL	NL	N/A	5,000	ICP-AES	N/A	N/A
Sulfate	-	NL	NL	NL	NL	N/A	N/A	N/A	N/A	N/A
Thallium	7440-28-0	NL	0.24	0.24	0.24	N/A	1	ICP-MS	N/A	N/A
Vanadium	7440-62-2	NL	18	18	5	N/A	5	ICP-MS	N/A	N/A
Zinc	7440-66-6	120	1,100	120	24	N/A	60	ICP-MS	N/A	N/A

QAPP Worksheet # 15k Reference Limits and Evaluation Table - Surface Water Inorganics

Notes:

1. NRWQC - USEPA. 2004. National Recommended Water Quality Criteria. United States Environmental Protection Agency
Office of Water, Office of Science and Technology.
2. PRWQS - PREQB. 2003. Puerto Rico Water Quality Standards Regulation, as Amended on March 2003.
Commonwealth of Puerto Rico Office of the Governor Environmental. Quality Board, Law No. 9 of June 18, 1970.
Priority is given to PRWQS.
3. EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (April 2009) for tap water, based on cancer risk of 1E-6 and hazard quotient of 0.1.
There is no RSL for total chromium. Screening value for chromium (VI) applied to chromium.
Screening value for vanadium and compounds is used for vanadium.
4. ILM05.4 Method is used.
5. If the PAL was higher than the CRQL then the PQLGs were determined by multiplying the PAL by 20%. If the PAL was lower than the CRQL then the PQLGs were made equivalent to the PAL.
^ - The compounds are bolded if the SOM01.2 CRQL is above the PQLGs, therefore a CLP modified request will be made to achieve the required lower limit.

Bolded analytes have PAL values lower than method quantitation limits. CDM will attempt to achieve lower limits via CLP modifications.

Acronyms:

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CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not Applicable
NRWQC = National Recommended Water Quality Criteria

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PAL = Project Action Limit
µg/L = microgram per liter

QAPP Worksheet # 15I
Reference Limits and Evaluation Table - Soil VOCs

Volatile Organic Compounds	CAS Number	Project Action Limit (µg/kg) ¹	Project Quantitation Limit Goal (µg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
1,1,1-Trichloroethane	71-55-6	2,000	400	N/A	5	N/A	N/A
1,1,2,2-Tetrachloroethane	79-34-5	3	3	N/A	5	N/A	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	NL	N/A	5	N/A	N/A
1,1,2-Trichloroethane	79-00-5	20	20	N/A	5	N/A	N/A
1,1-Dichloroethane	75-34-3	23,000	4,600	N/A	5	N/A	N/A
1,1-Dichloroethylene	75-35-4	60	12	N/A	5	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	NL	NL	N/A	5	N/A	N/A
1,2,4-Trichlorobenzene	120-82-1	5,000	1,000	N/A	5	N/A	N/A
1,2-Dibromo-3-chloropropane	96-12-8	NL	NL	N/A	5	N/A	N/A
1,2-Dibromoethane	106-93-4	NL	NL	N/A	5	N/A	N/A
1,2-Dichlorobenzene	95-50-1	17,000	3,400	N/A	5	N/A	N/A
1,2-Dichloroethane	107-06-2	20	10	N/A	5	N/A	N/A
1,2-Dichloropropane	78-87-5	30	6	N/A	5	N/A	N/A
1,3-Dichlorobenzene	541-73-1	NL	NL	N/A	5	N/A	N/A
1,3-Dichloropropene	542-75-6	4	4	N/A	5	N/A	N/A
1,4-Dichlorobenzene	106-46-7	2,000	400	N/A	5	N/A	N/A
1,4-Dioxane	123-91-1	NL	NL	N/A	100	N/A	N/A
2-Butanone	78-93-3	NL	NL	N/A	10	N/A	N/A
2-Hexanone	591-78-6	NL	NL	N/A	10	N/A	N/A
4-Methyl-2-pentanone	108-10-1	NL	NL	N/A	10	N/A	N/A
Acetone (2-propanone)	67-64-1	16,000	3,200	N/A	10	N/A	N/A
Benzene	71-43-2	30	6	N/A	5	N/A	N/A
Bromochloromethane	74-97-5	NL	NL	N/A	5	N/A	N/A
Bromodichloromethane	75-27-4	600	120	N/A	5	N/A	N/A
Bromoform (tribromomethane)	75-25-2	800	160	N/A	5	N/A	N/A
Bromomethane	74-83-9	NL	NL	N/A	5	N/A	N/A
Carbon disulfide	75-15-0	32,000	6,400	N/A	5	N/A	N/A
Carbon tetrachloride	56-23-5	70	14	N/A	5	N/A	N/A
Chlorobenzene	108-90-7	1,000	200	N/A	5	N/A	N/A
Chlorodibromomethane	124-48-1	400	80	N/A	5	N/A	N/A
Chloroethane	75-00-3	NL	NL	N/A	5	N/A	N/A
Chloroform	67-66-3	600	120	N/A	5	N/A	N/A
Chloromethane	74-87-3	NL	NL	N/A	5	N/A	N/A
cis-1,2-Dichloroethylene	156-59-2	400	80	N/A	5	N/A	N/A

QAPP Worksheet # 15I
Reference Limits and Evaluation Table - Soil VOCs

Volatile Organic Compounds	CAS Number	Project Action Limit (µg/kg) ¹	Project Quantitation Limit Goal (µg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
cis-1,3-Dichloropropene	10061-01-5	NL	NL	N/A	5	N/A	N/A
Cyclohexane	110-82-7	NL	NL	N/A	5	N/A	N/A
Dichlorodifluoromethane	75-71-8	NL	NL	N/A	5	N/A	N/A
Ethylbenzene	100-41-4	13,000	2,600	N/A	5	N/A	N/A
Isopropylbenzene	98-82-8	NL	NL	N/A	5	N/A	N/A
Methyl acetate	79-20-9	NL	NL	N/A	5	N/A	N/A
Methyl tert-butyl ether	1634-04-4	NL	NL	N/A	5	N/A	N/A
Methylcyclohexane	108-87-2	NL	NL	N/A	5	N/A	N/A
Methyl bromide	74-83-9	200	40	N/A	5	N/A	N/A
Methylene chloride	75-09-2	20	10	N/A	5	N/A	N/A
m-Xylene	108-38-3	210,000	42,000	N/A	5	N/A	N/A
o-Xylene	95-47-6	190,000	38,000	N/A	5	N/A	N/A
p-Xylene	106-42-3	200,000	40,000	N/A	5	N/A	N/A
Styrene	100-42-5	4,000	800	N/A	5	N/A	N/A
Tetrachloroethylene	127-18-4	60	12	N/A	5	N/A	N/A
Toluene	108-88-3	12,000	2,400	N/A	5	N/A	N/A
trans-1,2-Dichloroethylene	156-60-5	700	140	N/A	5	N/A	N/A
trans-1,3-Dichloropropene	10061-02-6	NL	NL	N/A	5	N/A	N/A
Trichloroethylene	79-01-6	60	12	N/A	5	N/A	N/A
Vinyl acetate	108-05-4	139,642	27,928	N/A	5	N/A	N/A
Trichlorofluoromethane	75-69-4	NL	NL	N/A	5	N/A	N/A
Vinyl chloride (chloroethene)	75-01-4	10	5	N/A	5	N/A	N/A

Notes

1. EPA. Appendix A - Generic SSLs for the Residential and Commercial/Industrial Scenarios, Appendix B - SSL Equations for Residential Scenario and Appendix C - Chemical Properties and Regulatory /Human Health Benchmarks for SSL Calculations.
http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_appa-c.pdf
2. Low soil option of SOM01.2 will be used. Two VOCs have CRQLs which exceed the Project Quantitation Limit Goal.
These values are highlighted. The SOM01.2 CLP modification request will be made to achieve the required lower limit.

Acronyms:

CRQL - Contract Required Quantitation Limit
MDL - method detection limit
NA - Not Applicable
NL - Chemical name not listed or screening value of this type not listed for the chemical
µg/kg - microgram per kilogram

QAPP Worksheet # 15m
Reference Limits and Evaluation Table - Soil SVOCs

Semivolatile Organic Compounds	CAS Number	Project Action Limit (µg/kg) ¹	Project Quantitation Limit Goal (µg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
1,1'-Biphenyl	92-52-4	NL	NL	N/A	170	N/A	N/A
1,2,4,5-Tetrachlorobenzene	95-94-3	NL	NL	N/A	170	N/A	N/A
2,2'-Oxybis (1-chloropropane)	108-60-1	NL	NL	N/A	170	N/A	N/A
2,3,4,6-Tetrachlorophenol	58-90-2	NL	NL	N/A	170	N/A	N/A
2,4-Dichlorophenoxybutyric Acid ³	94-75-7	400	80	N/A	NL ³	N/A	N/A
2,4,5-Trichlorophenol	95-95-4	270,000	54,000	N/A	170	N/A	N/A
2,4,6-Trichlorophenol	88-06-2	200	200	N/A	170	N/A	N/A
2,4-Dichlorophenol	120-83-2	1,000	200	N/A	170	N/A	N/A
2,4-Dimethylphenol	105-67-9	9,000	1,800	N/A	170	N/A	N/A
2,4-Dinitrophenol	51-28-5	200	100	N/A	330	N/A	N/A
2,4-Dinitrotoluene	121-14-2	0.8	0.8	N/A	170	N/A	N/A
2,6-Dinitrotoluene	606-20-2	0.7	0.7	N/A	170	N/A	N/A
2-Chloronaphthalene	91-58-7	NL	NL	N/A	170	N/A	N/A
2-Chlorophenol	95-57-8	4,000	800	N/A	170	N/A	N/A
2-Methylnaphthalene	91-57-6	NL	NL	N/A	170	N/A	N/A
2-Methylphenol (o-cresol)	95-48-7	15,000	3,000	N/A	170	N/A	N/A
2-Nitroaniline	88-74-4	NL	NL	N/A	330	N/A	N/A
2-Nitrophenol	88-75-5	NL	NL	N/A	170	N/A	N/A
3,3-Dichlorobenzidine	91-94-1	7	7	N/A	170	N/A	N/A
3-Nitroaniline	99-09-2	NL	NL	N/A	330	N/A	N/A
4,6-Dinitro-2-methylphenol	534-52-1	NL	NL	N/A	330	N/A	N/A
4-Bromophenyl-phenylether	101-55-3	NL	NL	N/A	170	N/A	N/A
4-Chloro-3-methylphenol	59-50-7	NL	NL	N/A	170	N/A	N/A
4-Chloroaniline	106-47-8	NL	NL	N/A	170	N/A	N/A
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	N/A	170	N/A	N/A
4-Methylphenol	106-44-5	NL	NL	N/A	170	N/A	N/A
4-Nitroaniline	100-01-6	NL	NL	N/A	330	N/A	N/A
4-Nitrophenol	100-02-7	NL	NL	N/A	330	N/A	N/A
Acenaphthene	83-32-9	570,000	114,000	N/A	170	N/A	N/A
Acenaphthylene	208-96-8	NL	NL	N/A	170	N/A	N/A
Acetophenone	98-86-2	NL	NL	N/A	170	N/A	N/A
Anthracene	120-12-7	12,000,000	2,400,000	N/A	170	N/A	N/A
Atrazine	1912-24-9	NL	NL	N/A	170	N/A	N/A

QAPP Worksheet # 15m
Reference Limits and Evaluation Table - Soil SVOCs

Semivolatile Organic Compounds	CAS Number	Project Action Limit (µg/kg) ¹	Project Quantitation Limit Goal (µg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
Benzaldehyde	100-52-7	NL	NL	N/A	170	N/A	N/A
Benz(a)anthracene	56-55-3	2,000	400	N/A	170	N/A	N/A
Benzo(a)pyrene	50-32-8	211	211	N/A	170	N/A	N/A
Benzo(b)fluoranthene	205-99-2	2,110	422	N/A	170	N/A	N/A
Benzo (g,h,i) perylene	191-24-2	NL	NL	N/A	170	N/A	N/A
Benzo(k)fluoranthene	207-08-9	21,096	4,219	N/A	170	N/A	N/A
Bis (2-chloroethoxy) methane	111-91-1	NL	NL	N/A	170	N/A	N/A
Bis(2-chloroethyl)ether	111-44-4	0.4	0.4	N/A	170	N/A	N/A
Bis(2-ethylhexyl)phthalate	117-81-7	123,121	24,624	N/A	170	N/A	N/A
Butyl benzyl phthalate	85-68-7	930,000	186,000	N/A	170	N/A	N/A
Caprolactam	105-60-2	NL	NL	N/A	170	N/A	N/A
Carbazole	86-74-8	600	300	N/A	170	N/A	N/A
Chrysene	218-01-9	160,000	32,000	N/A	170	N/A	N/A
Dibenz(a,h)anthracene	53-70-3	211	190	N/A	170	N/A	N/A
Dibenzofuran	132-64-9	NL	NL	N/A	170	N/A	N/A
Diethylphthalate	84-66-2	470,000	94,000	N/A	170	N/A	N/A
Dimethylphthalate	131-11-3	NL	NL	N/A	170	N/A	N/A
Di-n-butyl phthalate	84-74-2	2,300,000	460,000	N/A	170	N/A	N/A
Di-n-octyl phthalate	117-84-0	2,462,425	492,485	N/A	170	N/A	N/A
Fluoranthene	206-44-0	2,200,035	440,007	N/A	170	N/A	N/A
Fluorene	86-73-7	560,000	112,000	N/A	170	N/A	N/A
Hexachloro-1,3-butadiene	87-68-3	2,000	400	N/A	170	N/A	N/A
Hexachlorobenzene	118-74-1	1,077	215	N/A	170	N/A	N/A
Hexachlorocyclopentadiene	77-47-4	365,872	73,174	N/A	170	N/A	N/A
Hexachloroethane	67-72-1	500	250	N/A	170	N/A	N/A
Indeno(1,2,3-cd)pyrene	193-39-5	2,110	422	N/A	170	N/A	N/A
Isophorone	78-59-1	500	250	N/A	170	N/A	N/A
Naphthalene	91-20-3	18,769	3,754	N/A	170	N/A	N/A
Nitrobenzene	98-95-3	100	1,500	N/A	170	N/A	N/A

QAPP Worksheet # 15m
Reference Limits and Evaluation Table - Soil SVOCs

Semivolatile Organic Compounds	CAS Number	Project Action Limit (µg/kg) ¹	Project Quantitation Limit Goal (µg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
N-Nitrosodi-n-propylamine	621-64-7	0.05	0.05	N/A	170	N/A	N/A
N-Nitrosodiphenylamine	86-30-6	1,000	200	N/A	170	N/A	N/A
p-Chloroaniline	106-47-8	700	140	N/A	170	N/A	N/A
<i>Pentachlorophenol</i> ⁴	87-86-5	30	6.7	N/A	6.7	N/A	N/A
Phenol	108-95-2	100,000	20,000	N/A	170	N/A	N/A
Pyrene	129-00-0	2,912,620	582,524	N/A	170	N/A	N/A

Notes

1. EPA. Appendix A - Generic SSLs for the Residential and Commercial/Industrial Scenarios, Appendix B - SSL Equations for Residential Scenario and Appendix C - Chemical Properties and Regulatory /Human Health Benchmarks for SSL Calculations. http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_appa-c.pdf
2. Low soil option of SOM01.2 will be used. Several SVOCs have CRQLs which exceed the Project Quantitation Limit Goal. These values are highlighted. A SOM01.2 CLP contract modification request will be made to achieve the required lower limit.
3. *2,4-Dichlorophenoxybutyric Acid* is not included on the target compound list of method SOM01.1. The contract modification will include a request to add this compound the analytic procedure.
4. *Pentachlorophenol* will be analyzed by SIM Method SOM01.2 to achieve the Project Quantitation Limit.

Acronyms:

CRQL - Contract Required Quantitation Limit
MDL - method detection limit
NA - Not Applicable
NL - Chemical name not listed or screening value of this type not listed for the chemical
µg/kg - microgram per kilogram

QAPP Worksheet # 15n
Reference Limits and Evaluation Table - Soil Pesticides and PCBs

Compound	CAS Number	Project Action Limit (µg/kg) ¹	Project Quantitation Limit Goal (µg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
Pesticides							
4,4'-DDD	72-54-8	9,951	1,990	N/A	3.3	N/A	N/A
4,4'-DDE	72-55-9	7,025	1,405	N/A	3.3	N/A	N/A
4,4'-DDT	50-29-3	7,025	1,405	N/A	3.3	N/A	N/A
Aldrin	309-00-2	101	20	N/A	1.7	N/A	N/A
alpha-BHC	319-84-6	0.5	0.5	N/A	1.7	N/A	N/A
alpha-Chlordane	5103-71-9	0.0043	0.004	N/A	1.7	N/A	N/A
beta-BHC	319-85-7	3	3	N/A	1.7	N/A	N/A
delta-BHC	319-86-8	NL	1.7	N/A	1.7	N/A	N/A
Dieldrin	60-57-1	4	4	N/A	3.3	N/A	N/A
Endosulfan ³	115-29-7	18,000	3,600	N/A	NL ³	N/A	N/A
Endosulfan I	959-98-8	0.056	0.05	N/A	1.7	N/A	N/A
Endosulfan II	33213-65-9	0.056	0.05	N/A	3.3	N/A	N/A
Endosulfan sulfate	1031-07-8	62	12	N/A	3.3	N/A	N/A
Endrin	72-20-8	1,000	200	N/A	3.3	N/A	N/A
Endrin aldehyde	7421-93-4	0.29	0.1	N/A	3.3	N/A	N/A
Endrin ketone	53494-70-5	NL	3	N/A	3.3	N/A	N/A
gamma-BHC (Lindane)	58-89-9	9	1.8	N/A	1.7	N/A	N/A
gamma-Chlordane	5103-74-2	0.0043	0.004	N/A	1.7	N/A	N/A
Heptachlor	76-44-8	383	77	N/A	1.7	N/A	N/A
Heptachlor epoxide	1024-57-3	189	38	N/A	1.7	N/A	N/A
Methoxychlor	72-43-5	160,000	32,000	N/A	17	N/A	N/A
Toxaphene	8001-35-2	1,567	313	N/A	170	N/A	N/A
PCBs							
Aroclor-1016	12674-11-2	220	110	N/A	33	N/A	N/A
Aroclor-1221	11104-28-2	220	110	N/A	33	N/A	N/A
Aroclor-1232	11141-16-5	220	110	N/A	33	N/A	N/A
Aroclor-1242	53469-21-9	220	110	N/A	33	N/A	N/A
Aroclor-1248	12672-29-6	220	110	N/A	33	N/A	N/A

QAPP Worksheet # 15n
Reference Limits and Evaluation Table - Soil Pesticides and PCBs

Compound	CAS Number	Project Action Limit (µg/kg) ¹	Project Quantitation Limit Goal (µg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
Aroclor-1254	11097-69-1	220	110	N/A	33	N/A	N/A
Aroclor-1260	11096-82-5	220	110	N/A	33	N/A	N/A

Notes:

1. EPA. Appendix A - Generic SSLs for the Residential and Commercial/Industrial Scenarios, Appendix B - SSL Equations for Residential Scenario and Appendix C - Chemical Properties and Regulatory /Human Health Benchmarks for SSL Calculations.
http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_appa-c.pdf

2. Low soil option of SOM01.2 will be used. CRQLs which exceed the Project Quantitation Limit Goals are bolded and highlighted. A contract modification will be requested for those analytes to attempt to achieve lower reporting limits.

Acronyms:

CRQL - Contract Required Quantitation Limit

MDL - method detection limit

NA - Not Applicable

NL - Chemical name not listed or screening value of this type not listed for the chemical

µg/kg - Micrograms per kilogram

QAPP Worksheet # 15o
Reference Limits and Evaluation Table - Soil Inorganics

Inorganic Analytes	CAS Number	Project Action ¹ Limit (mg/kg)	Project Quantitation Limit Goal (mg/kg)	Analytical Method ²		Achievable Laboratory Limits	
				MDLs	CRQLs (mg/kg)	MDLs	QLs
Aluminum	7429-90-5	76,000	15,200	N/A	20	N/A	N/A
Antimony	7440-36-0	5	5	N/A	6	N/A	N/A
Arsenic	7440-38-2	29	14.5	N/A	1	N/A	N/A
Barium	7440-39-3	1,600	320	N/A	20	N/A	N/A
Beryllium	7440-41-7	63	12.6	N/A	0.5	N/A	N/A
Cadmium	7440-43-9	8	1.6	N/A	0.5	N/A	N/A
Calcium	7440-70-2	NL	500	N/A	500	N/A	N/A
Chromium (total)	7440-47-3	38	7.6	N/A	1	N/A	N/A
Cobalt	7440-48-4	NL	5	N/A	5	N/A	N/A
Copper	7440-50-8	NL	2.5	N/A	2.5	N/A	N/A
Cyanide (amenable)	57-12-5	40	8	N/A	2.5	N/A	N/A
Iron	7439-89-6	NL	10	N/A	10	N/A	N/A
Lead	7439-92-1	NL	1	N/A	1	N/A	N/A
Magnesium	7439-95-4	NL	500	N/A	500	N/A	N/A
Manganese	7439-96-5	NL	1.5	N/A	1.5	N/A	N/A
Mercury	7439-97-6	2	0.4	N/A	0.1	N/A	N/A
Nickel	7440-02-0	130	26	N/A	4	N/A	N/A
Potassium	7440-09-7	NL	500	N/A	500	N/A	N/A
Selenium	7782-49-2	5	4	N/A	3.5	N/A	N/A
Silver	7440-22-4	34	6.8	N/A	1	N/A	N/A
Sodium	7440-23-5	NL	500	N/A	500	N/A	N/A
Thallium	7440-28-0	0.7	0.5	N/A	2.5	N/A	N/A
Vanadium	7440-62-2	715	143	N/A	5	N/A	N/A
Zinc	7440-66-6	NL	6	N/A	6	N/A	N/A

QAPP Worksheet # 15o
Reference Limits and Evaluation Table - Soil Inorganics

Notes:

1. EPA. Appendix A - Generic SSLs for the Residential and Commercial/Industrial Scenarios, Appendix B - SSL Equations for for Residential Scenario and Appendix C - Chemical Properties and Regulatory /Human Health Benchmarks for SSL Calculations.
http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_appa-c.pdf
2. ICP-AES applies to analytes thallium and antimony, which CRQLs exceed the PQLGs.
A modification to method ILM05.4 will be requested to achieve the project goal.

Acronyms:

CRQL - Contract Required Quantitation Limit
MDL - method detection limit
NA - Not Applicable
NL - Chemical name not listed or screening value of this type not listed for the chemical
mg/kg - milligrams per kilogram

QAPP Worksheets 15p
Reference Limits and Evaluation Table - Soil & Sediment Quality Parameters

Analysis	CAS Number	Project Action Limit (mg/kg)	Project Quantitation Limit Goal (mg/kg)	Analytical Method			Achievable Laboratory Limits	
				MDLs	CRQLs	Option	MDLs	QLs
pH	N/A	N/A	N/A	± 0.5	± 0.5	N/A	TBD	TBD
TOC	N/A	N/A	100	N/A	100-500 mg/kg	N/A	TBD	TBD
Grain Size	N/A	N/A	N/A	N/A	N/A	N/A	TBD	TBD

Notes

CRQL = Contract Required Quantitation Limit
MDL = method detection limit
mg/kg = milligram per kilogram
TBD = to be determined

NA = Not applicable
PAL- Project Action Limit.
PQLG - Project Quantitation Limit Goal.

QAPP Worksheet # 15q
Reference Limits and Evaluation Table - Sediment VOCs

Volatile Organic Compounds	CAS Number	Project Action Limit ^{1,2} (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Analytical Method ³			Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	Source	MDLs	QLs
1,1,1-Trichloroethane	71-55-6	30.2	6	N/A	5	Low	N/A	N/A
1,1,2,2-Tetrachloroethane	79-34-5	1.36	1	N/A	5	Low	N/A	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	5	N/A	5	Low	N/A	N/A
1,1,2-Trichloroethane	79-00-5	1.24	1	N/A	5	Low	N/A	N/A
1,1-Dichloroethane	75-34-3	0.575	0.5	N/A	5	Low	N/A	N/A
1,1-Dichloroethylene	75-35-4	31	5	N/A	5	Low	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	858	171.6	N/A	5	Low	N/A	N/A
1,2,4-Trichlorobenzene	120-82-1	210	42	N/A	5	Low	N/A	N/A
1,2-Dibromo-3-chloropropane	96-12-8	NL	5	N/A	5	Low	N/A	N/A
1,2-Dibromoethane	106-93-4	NL	5	N/A	5	Low	N/A	N/A
1,2-Dichlorobenzene	95-50-1	16.5	8.25	N/A	5	Low	N/A	N/A
1,2-Dichloroethane	107-06-2	260	52	N/A	5	Low	N/A	N/A
1,2-Dichloropropane	78-87-5	481	96.2	N/A	5	Low	N/A	N/A
1,3-Dichlorobenzene	541-73-1	2,460	492	N/A	5	Low	N/A	N/A
1,4-Dichlorobenzene	106-46-7	318	63.6	N/A	5	Low	N/A	N/A
2-Butanone	78-93-3	NL	10	N/A	10	Low	N/A	N/A
2-Hexanone	591-78-6	58.2	11.64	N/A	10	Low	N/A	N/A
4-Methyl-2-pentanone	108-10-1	25.1	10	N/A	10	Low	N/A	N/A
Acetone	67-64-1	9.9	10	N/A	10	Low	N/A	N/A
Benzene	71-43-2	142	28.4	N/A	5	Low	N/A	N/A
Bromochloromethane	74-97-5	NL	5	N/A	5	Low	N/A	N/A
Bromodichloromethane	75-27-4	NL	5	N/A	5	Low	N/A	N/A
Bromoform	75-25-2	492	98.4	N/A	5	Low	N/A	N/A
Bromomethane	74-83-9	NL	5	N/A	5	Low	N/A	N/A
Carbon Disulfide	75-15-0	0.851	0.8	N/A	5	Low	N/A	N/A
Carbon Tetrachloride	56-23-5	64.2	12.84	N/A	5	Low	N/A	N/A
Chlorobenzene	108-90-7	8.42	5	N/A	5	Low	N/A	N/A
Chloroethane	75-00-3	NL	5	N/A	5	Low	N/A	N/A
Chloroform	67-66-3	121	24.2	N/A	5	Low	N/A	N/A
Chloromethane	74-87-3	NL	5	N/A	5	Low	N/A	N/A
cis-1,2-Dichloroethene	156-59-2	NL	5	N/A	5	Low	N/A	N/A
cis-1,3-Dichloropropene	10061-01-5	NL	5	N/A	5	Low	N/A	N/A
Cyclohexane	110-82-7	NL	5	N/A	5	Low	N/A	N/A
Dibromochloromethane	124-48-1	NL	5	N/A	5	Low	N/A	N/A

Volatile Organic Compounds	CAS Number	Project Action Limit ^{1,2} (µg/kg)	Project Quantitation Limit Goal (µg/kg)	Analytical Method ³			Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	Source	MDLs	QLs
Dichlorodifluoromethane	75-71-8	NL	5	N/A	5	Low	N/A	N/A
Ethylbenzene	100-41-4	175	35	N/A	5	Low	N/A	N/A
Isopropylbenzene	98-82-8	86	17.2	N/A	5	Low	N/A	N/A
Methyl Acetate	79-20-9	NL	5	N/A	5	Low	N/A	N/A
Methyl Tert-Butyl Ether	1634-04-4	NL	5	N/A	5	Low	N/A	N/A
Methylcyclohexane	108-87-2	NL	5	N/A	5	Low	N/A	N/A
Methylene Chloride	75-09-2	159	31.8	N/A	5	Low	N/A	N/A
m-Xylene	108-38-3	25.2	5.04	N/A	5	Low	N/A	N/A
o-Xylene	95-47-6	NL	5	N/A	5	Low	N/A	N/A
p-Xylene	106-42-3	NL	5	N/A	5	Low	N/A	N/A
Styrene	100-42-5	254	50.8	N/A	5	Low	N/A	N/A
Tetrachloroethene	127-18-4	468	93.6	N/A	5	Low	N/A	N/A
Toluene	108-88-3	1,220	244	N/A	5	Low	N/A	N/A
trans-1,2-Dichloroethene	156-60-5	654	130.8	N/A	5	Low	N/A	N/A
trans-1,3-Dichloropropene	10061-02-6	NL	5	N/A	5	Low	N/A	N/A
Trichloroethene	79-01-6	96.9	19.38	N/A	5	Low	N/A	N/A
Trichlorofluoromethane	75-69-4	NL	5	N/A	5	Low	N/A	N/A
Vinyl Chloride	75-01-4	31	6.2	N/A	5	Low	N/A	N/A
Xylenes (total)	1330-20-7	433	86.6	N/A	N/A	N/A	N/A	N/A

Notes

Source

1. U.S. EPA Region 3, December 2005, BTAG Freshwater Sediment Screening Benchmarks
2. U.S. Region 5, July 2003. RCRA Ecological Screening Levels
The criteria used for the Project Action Limit is the lower value of 1. and 2.
3. SOM01.2 Low Soil Option. Highlighted and bolded VOCs have CRQLs above their PQLGs. A contract modification will be requested to achieve the project goals.

Acronyms:

BTAG - Biological Technical Assistance Group
CRQL - Contract Required Quantitation Limit
MDL - method detection limit
N/A - Not applicable
ND - The criteria for this compound is below any detection limit
NL - Chemical name not listed or screening value of this type not listed for the chemical
PQLG - Project Quantitation Limit Goal
RCRA - Resource Conservation and Recovery Act
µg/kg - microgram per kilogram dry weight

QAPP Worksheet # 15r
Reference Limists and Evaluation Table - Sediment SVOCs

Semivolatile Organics	CAS Number	Project Action Limit (µg/kg) ¹⁻⁵	Project Quantitation Limit Goal (µg/kg)	Analytical Method ⁶			Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	Source	MDLs	QLs
1,1'Biphenyl	92-52-4	1,220	244	N/A	170	Low	N/A	N/A
2,2'-oxybis(1-Chloropropane)	108-60-1	NL	170	N/A	170	Low	N/A	N/A
2,4,5-Trichlorophenol	95-95-4	NL	170	N/A	170	Low	N/A	N/A
2,4,6-Trichlorophenol	88-06-2	208	170	N/A	170	Low	N/A	N/A
2,4-Dichlorophenol	120-83-2	81.7	80	N/A	170	Low	N/A	N/A
2,4-Dimethylphenol	105-67-9	29	20	N/A	170	Low	N/A	N/A
2,4-Dinitrophenol	51-28-5	7.51	5	N/A	330	Low	N/A	N/A
2,4-Dinitrotoluene	121-14-2	14.4	10	N/A	170	Low	N/A	N/A
2,6-Dinitrotoluene	606-20-2	39.8	30	N/A	170	Low	N/A	N/A
2-Chloronaphthalene	91-58-7	417	170	N/A	170	Low	N/A	N/A
2-Chlorophenol	95-57-8	42.5	40	N/A	170	Low	N/A	N/A
2-Methylnaphthalene	91-57-6	20.2	20	N/A	170	Low	N/A	N/A
2-Methylphenol	95-48-7	55.4	50	N/A	170	Low	N/A	N/A
2-Nitroaniline	88-74-4	NL	330	N/A	330	Low	N/A	N/A
2-Nitrophenol	88-75-5	NL	330	N/A	330	Low	N/A	N/A
3,3'-Dichlorobenzidine	91-94-1	28.2	20	N/A	170	Low	N/A	N/A
3-Nitroaniline	99-09-2	NL	330	N/A	330	Low	N/A	N/A
4,6-Dinitro-2-methylphenol	534-52-1	NL	330	N/A	330	Low	N/A	N/A
4-Bromophenyl-phenylether	101-55-3	1,230	246	N/A	170	Low	N/A	N/A
4-Chloro-3-methylphenol	59-50-7	NL	170	N/A	170	Low	N/A	N/A
4-Chloroaniline	106-47-8	146	100	N/A	170	Low	N/A	N/A
4-Chlorophenyl-phenylether	7005-72-3	NL	170	N/A	170	Low	N/A	N/A
4-Methylphenol	106-44-5	670	670	N/A	170	Low	N/A	N/A
4-Nitroaniline	100-01-6	NL	330	N/A	330	Low	N/A	N/A
4-Nitrophenol	100-02-7	NL	330	N/A	330	Low	N/A	N/A
Acenaphthene	83-32-9	150.0	100	N/A	170	Low	N/A	N/A
Acenaphthylene	208-96-8	5.9	2	N/A	170	Low	N/A	N/A

QAPP Worksheet # 15r
Reference Limists and Evaluation Table - Sediment SVOCs

Semivolatile Organics	CAS Number	Project Action Limit (µg/kg) ¹⁻⁵	Project Quantitation Limit Goal (µg/kg)	Analytical Method ⁶			Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	Source	MDLs	QLs
Acetophenone	98-86-2	NL	170	N/A	170	Low	N/A	N/A
Anthracene	120-12-7	57.2	50	N/A	170	Low	N/A	N/A
Atrazine	1912-24-9	6.62	6	N/A	170	Low	N/A	N/A
Benzaldehyde	100-52-7	NL	330	N/A	170	Low	N/A	N/A
Benzo(a)anthracene	56-55-3	108	21.6	N/A	170	Low	N/A	N/A
Benzo(a)pyrene	50-32-8	150	100	N/A	170	Low	N/A	N/A
Benzo(b)fluoranthene	205-99-2	10,400	2080	N/A	170	Low	N/A	N/A
Benzo(g,h,i)perylene	191-24-2	170	170	N/A	170	Low	N/A	N/A
Benzo(k)fluoranthene	207-08-9	240	240	N/A	170	Low	N/A	N/A
bis(2-Chloroethoxy)methane	111-91-1	NL	170	N/A	170	Low	N/A	N/A
bis(2-Chloroethyl)ether	111-44-4	3,520	704	N/A	170	Low	N/A	N/A
bis(2-Ethylhexyl)phthalate	117-81-7	180	170	N/A	170	Low	N/A	N/A
Butylbenzylphthalate	85-68-7	1,970	394	N/A	170	Low	N/A	N/A
Caprolactam	105-60-2	NL	170	N/A	170	Low	N/A	N/A
Carbazole	86-74-8	NL	170	N/A	170	Low	N/A	N/A
Chrysene	218-01-9	166	100	N/A	170	Low	N/A	N/A
Dibenz(a,h)anthracene	53-70-3	33	6.6	N/A	170	Low	N/A	N/A
Dibenzofuran	132-64-9	415	170	N/A	170	Low	N/A	N/A
Diethylphthalate	84-66-2	590	170	N/A	170	Low	N/A	N/A
Dimethylphthalate	131-11-3	NL	170	N/A	170	Low	N/A	N/A
Di-n-butylphthalate	84-74-2	4,012	802.4	N/A	170	Low	N/A	N/A
Di-n-octyl phthalate	117-84-0	40,600	8,120	N/A	170	Low	N/A	N/A
Fluoranthene	206-44-0	423	170	N/A	170	Low	N/A	N/A
Fluorene	86-73-7	35.0	30	N/A	170	Low	N/A	N/A
Hexachlorobenzene	118-74-1	20	20	N/A	170	Low	N/A	N/A
Hexachlorobutadiene	87-68-3	1380	276	N/A	170	Low	N/A	N/A
Hexachlorocyclopentadiene	77-47-4	901	180.2	N/A	170	Low	N/A	N/A
Hexachloroethane	67-72-1	876	170	N/A	170	Low	N/A	N/A
Indeno(1,2,3-cd)pyrene	193-39-5	200	200	N/A	170	Low	N/A	N/A
Isophorone	78-59-1	432	170	N/A	170	Low	N/A	N/A

QAPP Worksheet # 15r
Reference Limists and Evaluation Table - Sediment SVOCs

Semivolatile Organics	CAS Number	Project Action Limit (µg/kg) ¹⁻⁵	Project Quantitation Limit Goal (µg/kg)	Analytical Method ⁶			Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	Source	MDLs	QLs
Naphthalene	91-20-3	176	170	N/A	170	Low	N/A	N/A
Nitrobenzene	98-95-3	250	200	N/A	170	Low	N/A	N/A
N-Nitroso-di-n-propylamine	621-64-7	NL	170	N/A	170	Low	N/A	N/A
N-Nitrosodiphenylamine	86-30-6	2,680	536	N/A	170	Low	N/A	N/A
Pentachlorophenol	87-86-5	504	330	N/A	330	Low	N/A	N/A
Phenanthrene	85-01-8	204	170	N/A	170	Low	N/A	N/A
Phenol	108-95-2	49.1	40	N/A	170	Low	N/A	N/A
Pyrene	129-00-0	195	170	N/A	170	Low	N/A	N/A

Notes:

1. Long ER and Morgan LG, 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA 175pp.
2. Persaud, D., Jaagumagi, T and Hayton, A, Aug., 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Water Resources Branch, Ontario Ministry of Environment, Toronto, 27pp.
3. MacDonald, D.D., Ingersoil, C.G., and Berger, T.A. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystem. Archives of Environmental Contamination and Toxicology 39:20-31
4. U.S. EPA Region 3. December 2005, BTAG Freshwater Sediment Screening Benchmarks.
5. U.S. EPA. Region 5. July 2003. RCRA Ecological Screening Levels
The criteria used for the Project Action Limit is the lowest value of 1., 2., 3., 4., and 5.
6. SOM01.2 Low Soil Option. Several SVOCs have CRQLs above their PQLGs. A contract modification will be requested to achieve project goals.

Acronyms:

BTAG - Biological Technical Assistance Group
SVOC - semi-volatile organic compound
CRQL - Contract Required Quantitation Limit
MDL - Method Detection Limit
N/A - Not applicable

ND - The criteria for this compound is below any detection limit
NL - Chemical name not listed or screening value of this type not listed for the chemical
PQLG - Project Quantitation Limit Goal
RCRA - Resource Conservation and Recovery Act
µg/kg - microgram per kilogram dry weight

QAPP Worksheet # 15s
Reference Limits and Evaluation Table - Sediment Pesticides and PCBs

Compound	CAS Number	Project Action Limit (µg/kg) ¹⁻⁷	Project Quantitation Limit Goal (µg/kg)	Analytical Method ⁸		Achievable Laboratory Limits	
				MDLs	CRQLs (µg/kg)	MDLs	QLs
Pesticides							
4,4'-DDD	72-54-8	2	1	N/A	3.3	N/A	N/A
4,4'-DDE	72-55-9	2	1	N/A	3.3	N/A	N/A
4,4'-DDT	50-29-3	1	0.5	N/A	3.3	N/A	N/A
Aldrin	309-00-2	2	2	N/A	1.7	N/A	N/A
alpha-BHC	319-84-6	6	3	N/A	1.7	N/A	N/A
alpha-Chlordane	5103-71-9	3.24	2.43	N/A	1.7	N/A	N/A
beta-BHC	319-85-7	5	2.5	N/A	1.7	N/A	N/A
delta-BHC	319-86-8	16,400	8,200	N/A	1.7	N/A	N/A
Dieldrin	60-57-1	1.9	1	N/A	3.3	N/A	N/A
Endosulfan I	959-98-8	2.9	2.5	N/A	1.7	N/A	N/A
Endosulfan II	33213-65-9	1.94	1	N/A	3.3	N/A	N/A
Endosulfan sulfate	1031-07-8	5.4	4	N/A	3.3	N/A	N/A
Endrin	72-20-8	2.22	1	N/A	3.3	N/A	N/A
Endrin aldehyde	7421-93-4	480	240	N/A	3.3	N/A	N/A
Endrin ketone	53494-70-5	NL	3.3	N/A	3.3	N/A	N/A
gamma-BHC (Lindane)	58-89-9	2.37	2	N/A	1.7	N/A	N/A
gamma-Chlordane	5103-74-2	3.24	3	N/A	1.7	N/A	N/A
Heptachlor	76-44-8	68	34	N/A	1.7	N/A	N/A
Heptachlor epoxide	1024-57-3	2.47	2	N/A	1.7	N/A	N/A
Methoxychlor	72-43-5	13.6	7	N/A	17	N/A	N/A
Toxaphene	8001-35-2	0.109	0.05	N/A	170	N/A	N/A
PCBs							
Aroclor-1016	12674-11-2	7	5	N/A	33	N/A	N/A
Aroclor-1221	11104-28-2	12	10	N/A	33	N/A	N/A
Aroclor-1232	11141-16-5	600	300	N/A	33	N/A	N/A
Aroclor-1242	53469-21-9	170	85	N/A	33	N/A	N/A
Aroclor-1248	12672-29-6	30	30	N/A	33	N/A	N/A
Aroclor-1254	11097-69-1	60	36	N/A	33	N/A	N/A
Aroclor-1260	11096-82-5	50	40	N/A	33	N/A	N/A

QAPP Workshett # 15s
Reference Limits and Evaluation Table - Sediment Pesticides and PCBs

Notes:

1. Long ER and Morgan LG, 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA, 175pp
 2. Persaud, D., Jaagumagi, R. and Hayton, A. Aug., 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Water Resources Branch, Ontario Ministry of Environment, Toronto, 27pp.
 3. MacDonald, D.D., Ingersoll, C.G., and Berger, T.A. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental Contamination and Toxicology 39:20-31
 4. Suter, G.W. II, and Tsao, C.L. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota:1996 Revision. ES/ER/TM-96/R2
 5. U.S. EPA Region 3, December 2005, BTAG Freshwater Sediment Screening Benchmarks
 6. U.S. EPA. Region 5, July 2003. RCRA Ecological Screening Levels
 7. Suter, G.W. II, and Tsao, C.L. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota:1996 Revision. ES/ER/TM-96/R2
- The criteria used for the Project Action Limit is the lowest value of 1., 2., 3., 4., 5., 6., and 7.
8. SOM01.2 Low Soil Option. Several SVOCs have CRQLs above their PQLGs. A contract modification will be requested to achieve project goals.

Acronyms:

BTAG - Biological Technical Assistance Group
SVOC - semi-volatile organic compound
RCRA - Resource Conservation Recovery Act
CRQL - Contract Requirement Quantitation Limit
MDL - Method Detection Limit
N/A - Not applicable
NL - Chemical name not listed or screening value of this type not listed for the chemical
PQLG - Project Quantitation Limit Goal
µg/kg - micrograms per kilogram dry weight

QAPP Worksheet # 15t
Reference Limits and Evaluation Table - Sediment Inorganics

Inorganic Analytes	CAS Number	Project Action Limit (mg/kg) ¹⁻³	Project Quantitation Limit Goal (mg/kg)	Analytical Method ⁴		Achievable	
				MDLs	CRQLs mg/kg	MDLs	QLs
Aluminum	7429-90-5	NL	20	N/A	20	N/A	N/A
Antimony	7440-36-0	2	1	N/A	6	N/A	N/A
Arsenic	7440-38-2	6	2	N/A	1	N/A	N/A
Barium	7440-39-3	NL	20	N/A	20	N/A	N/A
Beryllium	7440-41-7	NL	0.5	N/A	0.5	N/A	N/A
Cadmium	7440-43-9	0.6	0.6	N/A	0.5	N/A	N/A
Calcium	7440-70-2	NL	500	N/A	500	N/A	N/A
Chromium ²	7440-47-3	26	13	N/A	1	N/A	N/A
Cobalt	7440-48-4	50	25	N/A	5	N/A	N/A
Copper	7440-50-8	16	8	N/A	2.5	N/A	N/A
Cyanide	57-12-5	0.1	0.05	N/A	2.5	N/A	N/A
Iron	7439-89-6	20,000	10,000	N/A	10	N/A	N/A
Lead	7439-92-1	31	15.5	N/A	1	N/A	N/A
Magnesium	7439-95-4	NL	500	N/A	500	N/A	N/A
Manganese	7439-96-5	460	230	N/A	1.5	N/A	N/A
Mercury	7439-97-6	0.2	0.1	N/A	0.1	N/A	N/A
Nickel	7440-02-0	16	8	N/A	4	N/A	N/A
Potassium	7440-09-7	NL	500	N/A	500	N/A	N/A
Selenium	7782-49-2	2	1	N/A	3.5	N/A	N/A
Silver	7440-22-4	1	1	N/A	1	N/A	N/A
Sodium	7440-23-5	NL	500	N/A	500	N/A	N/A
Thallium	7440-28-0	NL	2.5	N/A	2.5	N/A	N/A
Vanadium	7440-62-2	NL	5	N/A	5	N/A	N/A
Zinc	7440-66-6	120	24	N/A	6	N/A	N/A

QAPP Worksheet # 15t
Reference Limits and Evaluation Table - Sediment Inorganics

Notes:

1. Long ER and Morgan LG, 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration. Seattle, WA, 175pp
2. Persaud, D., Jaagumagi, R. and Hayton, A. Aug. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Water Resources Branch, Ontario Ministry of Environment, Toronto, 27pp.
3. U.S. EPA Region 3. December 2005. BTAG Freshwater Sediment Screening Benchmarks
The criteria used for the Project Action Limit is the lowest value of 1., 2., and 3.
4. ILM05.4 ICP-AES. Several inorganics have CRQLs above their PQGLs. Where possible, a contract modification will be requested to achieve the PQGLs.

Acronyms:

CRQL - Contract Required Quantitation Limit

MDL - Method Detection Limit

N/A - Not Applicable

NL - Chemical name not listed or screening value of this type not listed for the chemical.

PQGLs - Project Quantitation Limit Goals

µg/kg - microgram per kilogram dry weight

QAPP Worksheet # 15u
Reference Limits and Evaluation Table - Indoor Air VOCs

Volatile Organic Compounds	CAS Number	Project Action Limit (ppbv) ¹	Project Quantitation Limit Goal (ppbv) ¹	Analytical Method ³		Achievable Laboratory Limits	
				MDLs ² (ppbv)	CRQLs (ppbv)	MDLs	QLs
1,1,1-Trichloroethane	71-55-6	400	400	0.62	N/A	N/A	N/A
1,1,2,2-Tetrachloroethane	79-34-5	61	61	0.28	N/A	N/A	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	18	18	NL	N/A	N/A	N/A
1,1,2-Trichloroethane	79-00-5	28	28	0.50	N/A	N/A	N/A
1,1-Dichloroethane	75-34-3	120	120	0.27	N/A	N/A	N/A
1,1-Dichloroethylene⁴	75-35-4	50	50	0.22	N/A	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	NL	NL	NL	N/A	N/A	N/A
1,2,4-Trichlorobenzene	120-82-1	27	27	NL	N/A	N/A	N/A
1,2-Dibromo-3-chloropropane	96-12-8	0.21	0.21	NL	N/A	N/A	N/A
1,2-Dibromoethane⁴	106-93-4	0.026	0.026	0.24	N/A	N/A	N/A
1,2-Dichlorobenzene	95-50-1	33	33	0.44	N/A	N/A	N/A
1,2-Dichloroethane	107-06-2	2.3	2.3	0.24	N/A	N/A	N/A
1,2-Dichloropropane	78-87-5	87	87	0.21	N/A	N/A	N/A
1,3-Dichlorobenzene	541-73-1	17	17	0.36	N/A	N/A	N/A
1,4-Dichlorobenzene	106-46-7	130	130	0.70	N/A	N/A	N/A
2-Butanone	78-93-3	340	340	NL	N/A	N/A	N/A
2-Hexanone	591-78-6	NL	NL	NL	N/A	N/A	N/A
4-Methyl-2-pentanone	108-10-1	20	20	NL	N/A	N/A	N/A
Acetone	67-64-1	150	150	NL	N/A	N/A	N/A
Benzene	71-43-2	9.8	9.8	0.34	N/A	N/A	N/A
Bromochloromethane	74-97-5	NL	NL	NL	N/A	N/A	N/A
Bromodichloromethane	75-27-4	2.1	2.1	NL	N/A	N/A	N/A
Bromoform	75-25-2	21	21	NL	N/A	N/A	N/A
Bromomethane	74-83-9	1.3	1.3	NL	N/A	N/A	N/A
Carbon Disulfide	75-15-0	220	220	NL	N/A	N/A	N/A
Carbon Tetrachloride	56-23-5	2.6	2.6	0.42	N/A	N/A	N/A
Chlorobenzene	108-90-7	13	13	0.34	N/A	N/A	N/A
Chloroethane	75-00-3	3800	3800	NL	N/A	N/A	N/A
Chloroform	67-66-3	2.2	2.2	0.25	N/A	N/A	N/A

QAPP Worksheet # 15u
Reference Limits and Evaluation Table - Indoor Air VOCs

Volatile Organic Compounds	CAS Number	Project Action Limit (ppbv) ¹	Project Quantitation Limit Goal (ppbv) ¹	Analytical Method ³		Achievable Laboratory Limits	
				MDLs ² (ppbv)	CRQLs (ppbv)	MDLs	QLs
Chloromethane	74-87-3	44	44	NL	N/A	N/A	N/A
cis-1,2-Dichloroethene⁴	156-59-2	8.8	8.8	0.06	N/A	N/A	N/A
cis-1,3-Dichloropropene	10061-01-5	NL	NL	0.36	N/A	N/A	N/A
Cyclohexane	110-82-7	NL	NL	NL	N/A	N/A	N/A
Dibromochloromethane	124-48-1	1.2	1.2	NL	N/A	N/A	N/A
Dichlorodifluoromethane	75-71-8	40	40	NL	N/A	N/A	N/A
Ethylbenzene	100-41-4	51	51	0.27	N/A	N/A	N/A
Isopropylbenzene	98-82-8	81	81	NL	N/A	N/A	N/A
Methyl Acetate	79-20-9	1200	1200	NL	N/A	N/A	N/A
Methyl Tert-Butyl Ether⁴	1634-04-4	830	830	NL	N/A	N/A	N/A
Methylcyclohexane	108-87-2	750	750	NL	N/A	N/A	N/A
Methylene Chloride	75-09-2	150	150	NL	N/A	N/A	N/A
m-Xylene	1330-20-7	1600	1600	0.76	N/A	N/A	N/A
o-Xylene	1330-20-7	1600	1600	0.57	N/A	N/A	N/A
p-Xylene	1330-20-7	1600	1600	0.76	N/A	N/A	N/A
Styrene	100-42-5	230	230	1.64	N/A	N/A	N/A
Tetrachloroethene⁴	127-18-4	12	12	0.75	N/A	N/A	N/A
Toluene	108-88-3	110	110	0.99	N/A	N/A	N/A
trans-1,2-Dichloroethene	156-60-5	18	18	NL	N/A	N/A	N/A
trans-1,3-Dichloropropene	10061-02-6	NL	NL	0.22	N/A	N/A	N/A
Trichloroethene⁴	79-01-6	0.41	0.41	0.45	N/A	N/A	N/A
Trichlorofluoromethane	75-69-4	120	120	NL	N/A	N/A	N/A
Vinyl Chloride	75-01-4	11	11	0.33	N/A	N/A	N/A
Xylenes (total)	1330-20-7	1600	1600	NL	N/A	N/A	N/A

Notes:

- USEPA Office of Solid Waste and Emergency Response (OSWER) Draft Guidance EPA 530-D-02-004, November 2002.
located at <http://www.epa.gov/correctiveaction/eis/vapor.htm>
Risk = 1×10^{-4}
- USEPA Compendium method TO-15, p. 15-46, Table 4, January 1999
- USEPA Method TO-15 analysis by Gas chromatography/Mass Spectrometry (GC/MS)
- SIM method for the MDL
- The compounds are bolded if the TO-15 MDL is above the PQLGs, therefore a modified request will be made to achieve the required lower limit.

Acronyms:

CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not Applicable
NL = Chemical name not listed or screening value of this type not listed for the chemical
PAL = Project Action Limit.
PQLG = Project Quantitation Limit Goal.
ppbv = parts per billion by volume

QAPP Worksheet # 15v
Reference Limits and Evaluation Table - Sub-Slab Air VOCs

Volatile Organic Compounds	CAS Number	Project Action Limit (ppbv) ¹	Project Quantitation Limit Goal (ppbv) ¹	Analytical Method ³		Achievable Laboratory Limits	
				MDLs ²	CRQLs (ppbv)	MDLs	QLs
1,1,1-Trichloroethane	71-55-6	4,000	4,000	0.62	N/A	N/A	N/A
1,1,2,2-Tetrachloroethane	79-34-5	610	610	0.28	N/A	N/A	N/A
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	180	180	NL	N/A	N/A	N/A
1,1,2-Trichloroethane	79-00-5	280	280	0.50	N/A	N/A	N/A
1,1-Dichloroethane	75-34-3	1,200	1,200	0.27	N/A	N/A	N/A
1,1-Dichloroethylene⁴	75-35-4	500	500	0.22	N/A	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	NL	NL	NL	N/A	N/A	N/A
1,2,4-Trichlorobenzene	120-82-1	270	270	NL	N/A	N/A	N/A
1,2-Dibromo-3-chloropropane	96-12-8	2.1	2.1	NL	N/A	N/A	N/A
1,2-Dibromoethane	106-93-4	0.26	0.26	0.24	N/A	N/A	N/A
1,2-Dichlorobenzene	95-50-1	330	330	0.44	N/A	N/A	N/A
1,2-Dichloroethane	107-06-2	23	23	0.24	N/A	N/A	N/A
1,2-Dichloropropane	78-87-5	870	870	0.21	N/A	N/A	N/A
1,3-Dichlorobenzene	541-73-1	170	170	0.36	N/A	N/A	N/A
1,4-Dichlorobenzene	106-46-7	1,300	1,300	0.70	N/A	N/A	N/A
2-Butanone	78-93-3	3,400	3,400	NL	N/A	N/A	N/A
2-Hexanone	591-78-6	NL	NL	NL	N/A	N/A	N/A
4-Methyl-2-pentanone	108-10-1	200	200	NL	N/A	N/A	N/A
Acetone	67-64-1	1,500	1,500	NL	N/A	N/A	N/A
Benzene	71-43-2	98	98	0.34	N/A	N/A	N/A
Bromochloromethane	74-97-5	NL	NL	NL	N/A	N/A	N/A
Bromodichloromethane	75-27-4	21	21	NL	N/A	N/A	N/A
Bromoform	75-25-2	210	210	NL	N/A	N/A	N/A
Bromomethane	74-83-9	13	13	NL	N/A	N/A	N/A
Carbon Disulfide	75-15-0	2,200	2,200	NL	N/A	N/A	N/A
Carbon Tetrachloride	56-23-5	26	26	0.42	N/A	N/A	N/A
Chlorobenzene	108-90-7	130	130	0.34	N/A	N/A	N/A
Chloroethane	75-00-3	38,000	38,000	NL	N/A	N/A	N/A
Chloroform	67-66-3	22	22	0.25	N/A	N/A	N/A
Chloromethane	74-87-3	440	440	NL	N/A	N/A	N/A
cis-1,2-Dichloroethene⁴	156-59-2	88	88	0.06	N/A	N/A	N/A
cis-1,3-Dichloropropene	10061-01-5	NL	NL	0.36	N/A	N/A	N/A
Cyclohexane	110-82-7	NL	NL	NL	N/A	N/A	N/A
Dibromochloromethane	124-48-1	12	12	NL	N/A	N/A	N/A

QAPP Worksheet # 15v
Reference Limits and Evaluation Table - Sub-Slab Air VOCs

Volatile Organic Compounds	CAS Number	Project Action Limit (ppbv) ¹	Project Quantitation Limit Goal (ppbv) ¹	Analytical Method ³		Achievable Laboratory Limits	
				MDLs ²	CRQLs (ppbv)	MDLs	QLs
Dichlorodifluoromethane	75-71-8	400	400	NL	N/A	N/A	N/A
Ethylbenzene	100-41-4	510	510	0.27	N/A	N/A	N/A
Isopropylbenzene	98-82-8	810	810	NL	N/A	N/A	N/A
Methyl Acetate	79-20-9	12,000	12,000	NL	N/A	N/A	N/A
Methyl Tert-Butyl Ether	1634-04-4	8,300	8,300	NL	N/A	N/A	N/A
Methylcyclohexane	108-87-2	7,500	7,500	NL	N/A	N/A	N/A
Methylene Chloride	75-09-2	1,500	1,500	NL	N/A	N/A	N/A
m-Xylene	1330-20-7	16,000	16,000	0.76	N/A	N/A	N/A
o-Xylene	1330-20-7	16,000	16,000	0.57	N/A	N/A	N/A
p-Xylene	1330-20-7	16,000	16,000	0.76	N/A	N/A	N/A
Styrene	100-42-5	2,300	2,300	1.64	N/A	N/A	N/A
Tetrachloroethene	127-18-4	120	120	0.75	N/A	N/A	N/A
Toluene	108-88-3	1,100	1,100	0.99	N/A	N/A	N/A
trans-1,2-Dichloroethene	156-60-5	180	180	NL	N/A	N/A	N/A
trans-1,3-Dichloropropene	10061-02-6	NL	NL	0.22	N/A	N/A	N/A
Trichloroethene	79-01-6	4.1	4.1	0.45	N/A	N/A	N/A
Trichlorofluoromethane	75-69-4	1,200	1,200	NL	N/A	N/A	N/A
Vinyl Chloride	75-01-4	110	110	0.33	N/A	N/A	N/A
Xylenes (total)	1330-20-7	16,000	16,000	NL	N/A	N/A	N/A

Notes:

- USEPA Office of Solid Waste and Emergency Response (OSWER) Draft Guidance EPA 530-D-02-004, November 2002.
located at <http://www.epa.gov/correctiveaction/eis/vapor.htm>
Risk = 1×10^{-4}
- USEPA Compendium method TO-15, p. 15-46, Table 4, January 1999
- USEPA Method TO-15 analysis by Gas chromatography/Mass Spectrometry (GC/MS)
- SIM method for the MDL

Acronyms:

CRQL = Contract Required Quantitation Limit
MDL = method detection limit
N/A = Not Applicable
NL = Chemical name not listed or screening value of this type not listed for the chemical
PAL = Project Action Limit.
PQLG = Project Quantitation Limit Goal.
ppbv = parts per billion by volume

QAPP Worksheet #16
Project Schedule/Timeline Table

Figure 4 shows the project schedule.

QAPP Worksheet # 17

Sampling Design and Rationale

The field investigation will evaluate the nature and extent of contamination in several media, including groundwater, surface water, sediments, soil and air to evaluate appropriate remedial alternatives. Specifically, the RI is designed to collect the following information:

Groundwater

Determine the source/s of the VOC plume.
Determine the area, depth, and extent of groundwater contamination.
Determine the rate and direction of groundwater and contaminant movement.

Surface Water/Groundwater Seepage/Sediment

Determine if groundwater discharging to Rio Maunabo is transporting contamination to the surface water and sediments.

Soil (optional)

Determine if contaminants are present in the surface and subsurface soils at a source area/facility identified during groundwater screening.

Vapor Intrusion (optional)

Determine the extent of indoor air contamination and evaluate potential human risks (See worksheet # 9).

The field program will include reconnaissance activities, groundwater screening, monitoring well installation, existing public wells and new monitoring wells sampling, sediment, surface water, and seepage sampling, groundwater/surface water interaction, synoptic and long term water level measurements, aquifer testing and ecological characterization as shown in the worksheets listed below and are follow this worksheet. The field schedule is shown on Figure 4.

- Mobilization and demobilization (Worksheet 17a)
- Site reconnaissance (Worksheet 17b)
- Decontamination Procedures (Worksheet 17c)
- Groundwater Screening Investigation (Worksheet 17d)
- Lithologic Sampling and Logging (Worksheet 17e)
- Source area surface and subsurface soil sampling (Worksheet 17f)
- Natural Gamma Logging (Worksheet 17g)
- Aquifer testing (Worksheet 17h)
- Long term water level measurements (Worksheet 17i)
- Synoptic water level measurements (Worksheet 17j)

QAPP Worksheet # 17 Sampling Design and Rationale

- Monitoring well installation and development (Worksheet 17k)
- Monitoring well and public supply well sampling (Worksheet 17l)
- Groundwater/surface water interaction investigation (Worksheet 17m)
- Surface water, groundwater seepage and sediment sampling (Worksheet 17n)
- Vapor intrusion sampling (Worksheet 17o)
- Ecological field investigation (Worksheet 17p)

QAPP Worksheet # 17a Sampling Design and Rationale Mobilization/Demobilization

Site Access

EPA will be responsible for obtaining site access. CDM will assist EPA with site access. The following field sampling activities will require site access support:

- Establishment of command post area
- Groundwater screening investigation
- Municipal public supply well evaluation and sampling
- Soil sampling at a source area/facility identified during groundwater screening sampling.
- Monitoring well installation and sampling
- Vapor intrusion sampling at residences/buildings
- Onsite Survey of Potential Source Areas

CDM will provide a list of property owners (public and private) to be accessed during the field activities. The list will include the mailing address and telephone number of the property owners. Once EPA has established that access has been granted, sampling activities can begin. CDM will contact and coordinate with property owners and local officials (for work in public areas) to schedule sampling activities.

Mobilization/Demobilization

This event will consist of property access assistance, field personnel orientation, field office and equipment mobilization, field supply ordering, staging, and transport to the site. One major mobilization will be required at the beginning of the field activities and a major demobilization will be required at the end.

Field Equipment and Supplies

Equipment and field supply mobilization will entail ordering, renting, and purchasing all equipment needed for each part of the RI field investigation. This will also include staging and transferring all equipment and supplies to and from the site. Measurement and Test Equipment (M&TE) forms will be completed for rental or purchase of equipment (instruments) that will be utilized to collect field measurements. The field equipment will be inspected for acceptability, and instruments calibrated as required prior to use. A decontamination area will be constructed for sampling equipment and personnel. A separate decontamination pad will be constructed by the drilling subcontractor for drilling equipment.

Field Trailer, Utilities, and Services

EPA will assist with finding a suitable location for the command post area. Arrangements for the lease of a field trailer and associated utilities, a secure storage area for IDW, trash container, and portable sanitary facilities will be made. The command post area must be large enough to accommodate a 40-foot office trailer, at least two 20 cubic yard roll-off containers, one 10,000 gallon tank, portable sanitary facilities, a decontamination area, drilling equipment and supplies, drill rigs and subcontractor support vehicles, and CDM vehicles. Health and safety work zones, including personnel decontamination areas, will be established. Local authorities such as the police and fire departments will be notified prior to the start of field activities. Equipment will be demobilized at the completion of each field event, as necessary. Demobilized equipment will include sampling equipment, drilling subcontractor equipment, health and safety equipment, and decontamination equipment.

CDM

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QAPP Worksheet # 17a Sampling Design and Rationale Mobilization/Demobilization

Site Preparation

CDM will conduct ground truthing for overhead utilities and surface features around intrusive subsurface sampling locations. The drilling subcontractor will be responsible for contacting an appropriate utility location service to locate and mark out underground utilities. CDM plans to use existing roadway rights-of-way, open space, and clearings to the maximum extent possible to access sampling locations. However, it may be necessary to clear some areas of vegetation and trees in order to access sampling locations. The drilling subcontractor will be responsible for clearing vegetation. CDM will direct and oversee any necessary clearing activities conducted by the drilling subcontractor.

Field Planning Meetings

Prior to RI field activities, each field team member will review all project plans and participate in a field planning meeting. The meeting will be conducted by the CDM SM and RI task manager and attended by all field staff and the QA coordinator. All new field personnel will receive a comparable briefing if they do not attend the initial field planning meeting and/or the tailgate kick-off meeting. The meeting objective is to become familiar with the history of the site, health and safety requirements, field procedures, and related QC requirements. A field planning meeting may be held in the field instead of the office if this is more convenient for the personnel involved. Supplemental meetings may be conducted as required by any changes in site conditions or to review field operation procedures.

The meeting will briefly discuss and clarify:

- Objectives of the fieldwork
- Equipment and training needs, roles and responsibilities
- Health and safety requirements
- Field operating procedures, schedules of events, communications, individual assignments, and health and safety requirements
- Required QC measures
- Documents governing field work that must be on site

A written agenda, reviewed by the RITM, will be distributed and an attendance list signed. Copies of these documents will be maintained by the CDM SM in the project files and submitted to the EPA RAC II QA officer. Additional meetings will be held when the documents governing field work require it, when the scope of the assignment changes significantly, when the field staff changes, or if the RI task manager determines that maintenance of QC protocol requirements merits another meeting.

- Additionally, before initiating the sample collection activities, the following preparatory activities must be completed:
- Procure subcontractor services prior to the initiation of field activities.
- Before arriving on site, the field team will review and discuss elements of this QAPP and the HSP. Personal protective equipment and health and safety guidelines are specified for each activity in the HSP.
- Ensure that all sample analyses are scheduled through the EPA RSCC or subcontract laboratory if needed.
- Obtain required sample containers and preservatives. Additional sample bottles will be taken into the field to allow for breakage.
- The identification number, maintenance and calibration dates (by the supplier or CDM equipment coordinator), and the person(s) assigned to perform field sampling.

CDM

Final Quality Assurance Project Plan

QAPP Worksheet # 17a Sampling Design and Rationale Mobilization/Demobilization

Demobilization

After site work is complete, the FTL and/or designated field staff will be responsible for conducting an inventory of site equipment, for ensuring that equipment has been properly cleaned prior to removal offsite, for making arrangements for the discontinuance of utilities and other services that supported the operation of the field trailer and other site facilities, for securing any equipment and IDW to be left on site, and for following up with any additional sampling requirements related to the remaining IDW. A final site walkover will be performed to confirm the condition of the site and the security of monitoring equipment such as locked well caps.

Site Restoration

Some field activities are expected to occur on private and public properties. In the event that properties are impacted by field activities, the property will be restored, as near as practicable, to the conditions existing immediately prior to such activities. CDM will maintain photographic documentation of site conditions prior to commencement of and after completion of RI field activities. At the completion of the field activities, decontamination pad materials will be decontaminated and removed from the command post area, unless otherwise instructed by EPA. The decontamination and command post area will be restored, as near as practicable, to its original condition. CDM personnel will perform field oversight and health and safety monitoring during all site restoration field activities.

QAPP Worksheet #17b Sampling Design and Rationale Site Reconnaissance

Site reconnaissance activities will be performed to support mobilization and to prepare for drilling and sampling activities. During the site reconnaissance, sampling locations will be identified and marked; property boundaries and utility rights-of-way will be located; utility mark outs will be performed; and photographs will be taken. Site reconnaissance activities also include oversight of the cultural resources subcontractor and surveying subcontractor.

Individual reconnaissance activities are required to support implementation of specific sampling programs. Site reconnaissance activities will occur prior to conducting the following sampling activities:

- **Groundwater Screening/Monitoring Well Installation Reconnaissance** - Prior to the groundwater screening and monitoring well drilling activities, the field team will visit the proposed groundwater screening and monitoring well locations to identify exact locations and assess potential logistical issues and physical access constraints for the drill rigs. Prior to performing any drilling, CDM's drilling subcontractor will request a utility markout to identify the locations of underground utilities. CDM will verify that the utility markout was performed before drilling activities begin. Potential problem locations will be documented and photographed and locations may be adjusted to facilitate access.
- **Surface Water and Sediment Sampling** - Prior to conducting the surface water and sediment sampling and surface water/groundwater interaction study, the field team will visit the proposed locations on the Rio Maunabo to assess potential logistical issues, safety issues, and physical access constraints. Potential problem locations will be documented and photographed and sampling locations may be adjusted based on the reconnaissance.
- **Topographic Survey Oversight** - A topographic map of the site will not be created since the site consists of a large area and a source area has not been identified. An ortho-rectified aerial photograph will be used as the base map for well and sample locations and figure development. Two surveying events are anticipated: One will occur immediately following the groundwater screening investigation and the second will occur after the monitoring wells are installed. It is anticipated that the locations and elevations of the groundwater screening points, surface water and sediment samples, groundwater/surface water interaction points, and stream staff gauge will be surveyed during the first surveying event. The location and elevation of monitoring wells will be surveyed during the second surveying event. Three elevations will be determined at each monitoring well: the ground surface, the top of the inner casing, and the top of the outer casing.
- **Cultural Resources Survey Oversight** - The CDM cultural resources survey subcontractor will conduct a cultural resources survey covering the study area. The Stage 1A Cultural Resources Survey will be prepared in order to determine the presence or absence of cultural resources which may be impacted by the implementation of any remedial actions. The Stage 1A survey is the initial level of survey and requires comprehensive documentary research and an initial walk-over reconnaissance and surface inspection. CDM will oversee the on-site activities of the cultural resources subcontractor.
- **Soil Source and Vapor Intrusion Sampling (Optional)** - Identify and mark soil source investigation boring locations. Identify four residences/building locations for the sub-slab and indoor air sampling.

QAPP Worksheet #17b Sampling Design and Rationale Site Reconnaissance

CDM will also conduct on-site surveys of potential source areas previously identified by EPA's SAT 2 Team and at a Dry Cleaner identified by CDM and EPA during the site visit. The reconnaissance will include visual inspection of the interiors of the buildings and the exterior facility property for evidence of past and present disposal areas or discharge points (floor drains, discharge pipes, waste handling practices, etc.), discussions with current owners/operators, and search of PREQB records for additional historical information on site operations and waste disposal. On-site surveys will be conducted at the following properties:

- Five light industrial facilities currently owned by PRIDCO
 - Centro de Acopio Manufacturing
 - Juan Orozco Limited, Inc.
 - Puerto Rico Beverage
 - Plastic Home Products
 - FEMA Storage Facility
- PRASA Wastewater Treatment Plant
- El Negro Auto Body/Parts Shop
- Esso Gas Station
- Total Gas Station
- Maunabo Dry Cleaning

QAPP Worksheet # 17c Sampling Design and Rationale Decontamination Procedures

Decontamination Procedures

Field decontamination will be performed on all personnel and equipment that enters the exclusion zone in accordance with TSOP 4-5. Personnel decontamination procedures will be implemented to prevent worker exposure to site contaminants. Equipment decontamination procedures will be implemented to prevent cross-contamination of environmental samples and prevent off-site migration of contaminants as a result of site investigation activities.

Personal Protective Equipment

- Non-residual detergent (Alconox) and tap water rinse
- Respirator sanitizer (for respirator or self contained breathing apparatus [SCBA] face piece)
- Thorough rinse with potable water
- Air dry

Field Monitoring and Geophysical Logging Equipment

Instruments should be cleaned per manufacturer's instructions. The electronic water level indicators, geophysical logging equipment, and water quality parameter probes cannot be rinsed with solvents or acids. The electronic water level indicators will be decontaminated with a non-phosphate detergent, tap water rinse, and a final distilled/deionized water rinse prior to use at each well. The water quality parameter probes will be rinsed prior to and after each use with deionized/distilled water only.

Well Casings

Well casings must be steam cleaned prior to installation to ensure that all oils, greases, and waxes have been removed. The casings should be stored using clean polyethylene sheeting to keep the possibility of contamination to a minimum.

Drilling Equipment and Other Large Pieces of Equipment

All drilling equipment that comes in contact with the soil must be steam cleaned before use, and after drilling each borehole. This includes drill rods, bits and augers, dredges, or any other large piece of equipment. Sampling devices such as split-spoons must be decontaminated, after each use, by the procedure listed below.

Sampling Apparatus

General Considerations:

All sampling apparatus must be properly decontaminated prior to its use in the field to prevent cross-contamination. Equipment should be decontaminated after usage (once a day or on an as needed basis). Decontamination will be performed in an area outside the contamination zone. Enough equipment will be available to be dedicated to the sampling points planned each day.

QAPP Worksheet # 17c Sampling Design and Rationale Decontamination Procedures

Decontamination Procedure:

The required decontamination procedure for all sampling equipment is:

- * a. wash and scrub with low phosphate detergent
- * b. tap water rinse
- ** c. 10 percent nitric acid rinse, ultra pure grade (one percent solution will be used when carbon steel equipments, such as split-spoons, are used)
- d. demonstrated analyte-free water rinse
- *** e. acetone or isopropanol rinse (all solvents must be pesticide-grade or better)
- **** f. demonstrated analyte-free water rinse (amount of water must be at least five times that of the solvents used)
- g. air dry
- h. wrap in aluminum foil, shiny side out, for transport
- * Tap water must be from a municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute.
- ** Nitric acid rinse will only be used when samples are collected for inorganics
- *** Solvent rinse required only when sampling for organics.
- **** A sample of the demonstrated analyte-free water will be collected and submitted for chemical analysis. Analytical results will be kept on-site. Determination of analyte-free water will be according to the EPA Region II CERCLA QA Manual (EPA 1989) (see page 59).

While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result from the interaction of the gloves with the organic solvents.

Decontamination Equipment

- Steam cleaner
- Power source (e.g., generator), if required
- Distilled/deionized water
- Demonstrated analyte-free water
- Potable water
- Polyethylene sheeting
- Deep basins
- Utility knife
- Brush

**QAPP Worksheet # 17c
Sampling Design and Rationale
Decontamination Procedures**

- Non-phosphate detergent (i.e. Alconox)
- Acetone or isopropynol (pesticide-grade)
- Aluminum foil
- Personnel protective equipment
- Air monitoring equipment and calibration gas
- 10 percent nitric acid (one percent when needed), ultra pure grade

QAPP Worksheet # 17d Sampling Design and Rationale Groundwater Screening Investigation

Describe and provide a rationale for choosing the sampling approach: The Groundwater Screening Investigation is meant to obtain quick data regarding the lateral and horizontal extent of contamination to facilitate field decisions regarding monitoring well locations. Geoprobe direct push technology (DPT) is a quick screening methods that can provide the lateral and vertical extent of the contaminant plume. The objectives of the groundwater screening survey include:

- Estimate the vertical and lateral boundaries of groundwater contamination
- Provide basis for selection of monitoring well locations, depths, and screen intervals
- Provide preliminary information on lithology of the alluvium aquifer

Sampling design and rationale:

Groundwater screening will be performed at up to 28 locations along four transects using the DPT sampling method. Twenty-four proposed groundwater screening locations are shown on Figure 5. Four contingency screening locations, not shown on Figure 5, are included to provide flexibility to collect additional groundwater screening samples to investigate potential source areas and to refine VOC concentrations between sampling locations or at the ends of transects. Groundwater screening at the contingency locations will be based on evaluation of the data from previous locations. The contingency screening locations will be approved by EPA before sampling begins.

The transects are generally oriented perpendicular to the estimated groundwater flow direction but access and physical constraints on the locations were also considered. Actual sampling locations will be based on the results of the on-site reconnaissance and will be confirmed with EPA prior to conducting the sampling.

Based on review of available geologic information, the affected Maunabo public supply wells are drilled to total depths of 80 to 125 feet. The alluvium is thin to the north of the valley (approximately 20 feet thick), near the FEMA Storage Facility and thickens to approximately 170 to 200 feet toward the south, near Maunabo #1 and the Rio Maunabo (Adolphson et al. 1977). The screened interval of Maunabo #1 is reportedly 50 to 90 feet bgs. The groundwater table is generally less than 10 feet bgs in the site area and, for estimating purposes, is assumed to be 10 feet bgs. The estimated total depth of the groundwater screening samples along Transect 1 (T-1), T-2, and T-4 is 130 feet bgs. This depth is considered adequate based on the available information on the depths of the Maunabo public supply well screens. The total depth of screening samples along T-3 is estimated at 70 feet because the bedrock is shallower in that area. Table 2 summarizes the screening number of samples and sample frequency/intervals that will be collected during the groundwater screening investigation. Fewer samples may be collected, depending on the results of the sampling.

It is assumed that all of the locations along T-1 and T-4 will be drilled and samples will be collected from all of the proposed depth intervals. For T-2 and T-3, VOC data from the previous day's sampling will be evaluated to aid in the determination of when to terminate sampling along the transect. Samples will be shipped on a daily basis to a laboratory for VOC analysis with a 24-hour turn-around time. Because of the low concentrations of VOCs detected in the public supply wells, sample quantitation limits for VOCs will be less than 1 µg/L. Groundwater samples will be analyzed by EPA method SOM01.2 or an equivalent method for trace level VOCs. With the exception of ketones, this method provides detection limits of 0.5 µg/L.

To establish a profile of groundwater contamination at each groundwater screening location, a DPT probe fitted with a screen will be driven to the target depth and a groundwater screening sample will be collected. Sampling will proceed upward, toward the ground surface, from the terminal depth. Groundwater samples will be collected at 10-foot intervals at all of the screening points. The final sample will be collected at a depth of two feet bgs.

QAPP Worksheet # 17d Sampling Design and Rationale Groundwater Screening Investigation

Each sampling interval will be purged before it is sampled. A peristaltic pump and polyethylene tubing will be used to purge the well point. The DPT rods will be purged to clear the screen of fines and produce as clear a sample as possible. Purge water will be monitored for pH, conductivity, temperature, dissolved oxygen, and turbidity. Once the monitoring parameters have stabilized, the polyethylene tubing will be removed, outfitted with a check valve, and used to collect the sample.

Samples will be shipped to a fixed-base laboratory for trace VOC analysis on a 24-hour turnaround basis. Laboratory services will be obtained using EPA's FASTAC strategy.

The CDM SM and RITM will hold daily discussions with the EPA RPM and hydrogeologist to evaluate sample analytical data and to determine when to terminate sampling. Based on a review of the VOC data and discussions with EPA, sample locations and/or sample depths may be modified or sample locations may be deleted. Any such modifications will be approved by the EPA RPM.

The vertical profile sampling boreholes will be abandoned using a tremied cement-bentonite mixture after all sampling has been completed. The boring locations will be restored to pre-existing conditions.

Field procedures for this activity are detailed in:

- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Read Instruments
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4 Packing and Shipping Samples Preserved with Hydrochloric acid
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-1 Geoprobe Sampling, Section 5.3 Groundwater Sampling
- TSOP 3-6 Underground Facility Location
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation

QAPP Worksheet # 17d Sampling Design and Rationale Groundwater Screening Investigation

Field procedures for this activity are detailed in (continued):

- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

Analytical groups/concentrations: A total of 334 screening samples will be collected. Groundwater screening samples will be analyzed for trace VOCs with 24 hour turnaround for faxed results (Worksheet #18). Specific conductance, pH, DO, temperature, Eh and turbidity will also be collected in accordance with the equipment manuals.

Sampling locations: Along transects shown in Figure 5. No background samples will be collected because the screening is designed to determine the extent of the plume.

Number of samples/frequency: Groundwater samples will be collected at the water table and every 10 feet thereafter to the top of bedrock or refusal. Sample naming is detailed on Worksheet #27.

QAPP Worksheet # 17e Sampling Design and Rationale Lithologic Sampling and Logging

Describe and provide a rationale for choosing the sampling approach: Preliminary lithological information will be collected to enhance the CSM, support development of the hydrogeologic framework, and to provide additional information to support selection of permanent monitoring well locations.

Sampling design and rationale: Subsurface soil samples will be collected at eight groundwater screening locations across the site to provide lithological information to enhance the CSM and to provide additional information to support selection of permanent monitoring well locations and construction materials. The proposed lithologic sampling and logging locations are shown on Figure 5

Field procedures for this activity are detailed in:

- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-1 Geoprobe Sampling, Section 5.1 Soil Sampling
- TSOP 3-5 Lithologic Logging
- TSOP 3-6 Underground Facility Location
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

Analytical groups: No samples will be collected for chemical analysis.

Sample locations: Refer to Figure 5.

Number of samples/frequency: At each of the eight locations, 4-foot soil “cores” in plastic sleeves will be collected at 10-foot intervals using DPT, starting at the ground surface and proceeding to the terminal depth of the boring (130 feet for transects T-1, T-2, and T-4 and 70 feet for transect T-3). Three locations along the T-1 transect, two locations along the T-2 and T-3 transects, one location along the T-4 transect will be selected for lithologic sampling and logging. A total of 100 samples will be collected for lithologic logging: 84 samples from the T-1, T-2, and T-4 transects and 16 from the T-3 transect. Lithologic logging will be performed by the on-site geologist and recorded in the field log book.

QAPP Worksheet #17f
Sampling Design and Rationale
Source Area Surface and Subsurface Soil Sampling (Optional)

Describe and provide a rationale for choosing the sampling approach: The objective of the source area soil boring sampling is to characterize the surface and subsurface soils at a potential source area. The data will supplement previous source area soil sampling data conducted by EPA's Region II SAT (EPA 2006b-g). Surface and subsurface soil sampling in a source area or areas is considered optional and will only be conducted if the on-site survey or the groundwater investigation activities identify a likely contaminant source or sources. CDM will notify EPA if a potential source area is located. Any surface or subsurface soil sampling activities will be approved by EPA.

Sampling design and rationale: It is assumed that one source area will be investigated and surface and subsurface soil samples will be collected at six locations in the vicinity of the source. One surface soil sample (0 to 1 foot bgs) will be collected at each of the six soil boring locations. Subsurface soil samples will be collected using a DPT rig. Continuous subsurface soil cores will be collected at 4-foot intervals from 1 foot below the ground surface to the groundwater table. It is estimated up to three, 4-foot cores will be collected from each location. One soil sample will be collected from each 4-foot core for a total of 18 subsurface soil samples.

Upon retrieval from the drill rod, each 4-foot core will be screened for VOCs using a PID. The onsite geologist will select the interval for analysis using the PID readings together with visual observations of any potential source materials. If significant contamination is identified in other depth intervals by either visual observation or PID readings, additional samples may be collected and documented on a Field Change Request Form.

The lithology of each sample will be characterized and logged by the field geologist. Depth to groundwater, if encountered, and PID readings also will be recorded in the log. To prevent cross-contamination, drill rods will be decontaminated between successive locations and new, polyethylene sleeves will be used for each sample.

QAPP Worksheet #17f
Sampling Design and Rationale
Source Area Surface and Subsurface Soil Sampling (Optional)

Field procedures for this activity are detailed in:

- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-3 Surface Soil Sampling, with a RAC II clarification
- TSOP 1-4 Subsurface Soil Sampling, with RAC II clarification, Section 5.2.5.4
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 1.4 Packing Environmental Samples
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-1 Geoprobe Sampling, Section 5.1 Soil Sampling
- TSOP 3-6 Underground Facility Location
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

Analytical groups/concentration: Surface and subsurface soil samples will be analyzed for full TCL/TAL analytes/compounds, pH, TOC and half of the samples for grain size.

Sampling locations: Soil samples will be collected from 6 locations over the suspected source area. Based on an estimated depth to groundwater of 10 feet, three samples per boring will be collected for a total of 18 subsurface soil samples.

Number of samples/frequency: Six surface soil and 18 subsurface soil samples will be collected based on an estimated depth to groundwater of 10 feet. There will be three subsurface samples and one surface soil sample per boring.

QAPP Worksheet #17g Sampling Design and Rationale Natural Gamma Logging

Describe and provide a rationale for choosing the sampling approach. Gamma logs will assist with identification of clay layers in the overburden and will be correlated with lithologic logs. The determination of the clay layers or areas will facilitate the fate and transport evaluation.

Sampling design and rationale: Once well construction is complete, natural gamma logs will be run in the deep well of each monitoring well pair and in the three supply wells. Downhole geophysical logging will be conducted in accordance with CDM's TSOP 3-4 Geophysical Logging, Calibration, and Quality Control. The gamma logs will be run after the wells have been completed.

The downhole geophysical logging will be performed by CDM's project geologist in accordance with the manufacturer's specifications. The equipment supplier will be responsible for the calibration of the probes, in accordance with the manufacturer's instructions, prior to shipment. Field personnel should be familiar with TSOP 3-4 and the manufacturer's specifications for the logging instruments. The downhole logging equipment will be decontaminated between each well in accordance with the manufacturer's specifications and the procedures outlined in Worksheet 17c.

At each location, CDM will set up a portable logging system consisting of a generator, computer (with logging software), and drawworks (cable, tool power supply, winch, and tripod). The natural gamma log will be run by first connecting the tool to the cable and setting it in the borehole so that the reference is to ground surface. The tool will be run at a speed of between 15 and 18 feet per minute. Data will be collected as the tool is first lowered to the bottom of the hole and then raised back to the surface. The two sets of data (up and down) provide a check on instrument function and redundancy in case of an instrument malfunction.

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 3-4 Geophysical logging, Calibration and Quality Control, Section 5.2.B.5 Nuclear Logging
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

QAPP Worksheet #17g
Sampling Design and Rationale
Natural Gamma Logging

Analytical groups: No chemical samples will be collected.

Number of samples/frequency: Gamma logs will be run at the deep well of each pair of monitoring wells and in the three supply wells.

QAPP Worksheet #17h Sampling Design and Rationale Aquifer Testing

Describe and provide a rationale for choosing the sampling approach. Slug tests will be performed on selected monitoring wells (assume 19 wells) that represent a variety of depths, lithology types and locations across the large site.

Sampling design and rationale: Slug tests will be conducted at monitoring wells that cover a range of depths, lithology types, and locations across the site. Slug test results will be used to estimate hydraulic conductivity of the aquifer. The slug tests will be conducted by adding or removing/displacing a known volume to or from the monitoring well to create a rapid rise or fall in water level. Water levels will be measured as the water in the well returns to static (pre-test) conditions. Water will be displaced with a 5 foot long, 3 inch diameter solid piece of polyvinyl chloride (PVC). The rate of water recovery will be measured with a pressure transducer and data recorder. Both rising and falling head slug tests will be conducted.

Slug test data will be evaluated using the Hvorslev Slug Test Method (Hvorslev 1951) and/or the Bouwer and Rice Slug test Method (Bouwer and Rice 1976). The most appropriate method will be determined by the project geologist.

If the EPA determines that additional testing is required, a limited (i.e., 24-hour) pump test will be conducted using Maunabo 1 public supply well as a pumping well. If it is decided that a 24-hour pump test will be conducted, a work plan letter and a QAPP addendum will be submitted describing the details of the aquifer test.

Field procedures for this activity are detailed in Appendix B:

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- TSOP 4-6 Hydraulic Conductivity Testing, Section 5.2
- Worksheet 17c Decontamination Procedures

Analytical Groups: No samples will be collected for analytical testing.

Number of samples/frequency: Slug tests will be conducted at an estimated 19 monitoring wells.

QAPP Worksheet #17i Sampling Design and Rationale Long Term Water Level Monitoring

Describe and provide a rationale for choosing the sampling approach: The overall objective of the long term water level monitoring program is to collect data to evaluate temporal fluctuations in water levels in the vicinity of the affected municipal supply wells in response to precipitation and local pumping. The data will also be used to support development of the site conceptual model and in the evaluation of groundwater flow.

Sampling design and rationale: Long term water level monitoring will be conducted in four shallow and four deep monitoring wells and will occur over a period of four weeks. Data will be collected using in-situ water level monitoring instruments capable of storing water level data for the duration of the test and equipped with barometric pressure compensation (Level Troll or equivalent). To provide baseline water levels and to verify the water level measurements, manual water levels will be collected at the start of monitoring; at weekly intervals during monitoring; and at the conclusion of the monitoring. To ensure that the instruments are operating properly, monitoring instruments will be checked on a weekly basis and the data downloaded and checked. At the end of the monitoring period, the data will be downloaded and stored for evaluation. To evaluate precipitation effects on water levels, precipitation data for the monitoring period will be obtained from a weather station. Before initiating water level measurements, a survey of the location and elevation for each monitoring location will be made by a licensed land surveyor under subcontract to CDM. Elevation measurements will be made at marked water level measuring points on the steel casing and on the adjacent ground surface.

Field procedures for this activity are detailed in:

- TSOP 1-6 Water Level Measurement
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- TSOP 4-8 Environmental Data Management
- Worksheet 17c Decontamination Procedures
- Appendix E Data Management

Analytical groups/concentration: There will be no chemical testing.

QAPP Worksheet #17i
Sampling Design and Rationale
Long Term Water Level Monitoring

Sampling locations: Long term water level monitoring will be conducted in four shallow and four deep monitoring wells.

Number of samples/frequency: The monitoring will occur over a period of four weeks.

QAPP Worksheet #17j Sampling Design and Rationale Synoptic Water Level Measurement

Describe and provide a rationale for choosing the sampling approach: Two rounds of synoptic water level measurements will be collected with an electronic water level meter at each monitoring well prior to collection of groundwater samples. Measurements will be collected to define groundwater flow at the site.

Sampling Design and rationale: Synoptic water level measurements will be used to construct groundwater contour maps for each of the shallow and deep groundwater monitoring zones.

Before taking water level measurements, the location and elevation of each monitoring well will be surveyed by a licensed surveyor. Elevation measurements will be made at marked water level measuring points on the inner casing, the top of outer protective casing, and the adjacent ground surface. The wells will be allowed to equilibrate after development for a minimum of two weeks before water level measurements are taken.

Field procedures for this activity are detailed in Appendix B

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

Analytical groups: No chemical analysis will be conducted.

Number of samples/frequency: Two rounds of synoptic water level measurements will be collected from the 19 monitoring wells in conjunction with the two rounds of groundwater sampling.

QAPP Worksheet #17k Sampling Design and Rationale Monitoring Well Installation and Development

Describe and provide a rationale for choosing the sampling approach: A total of sixteen monitoring wells will be installed in pairs consisting of a deep and a shallow well to define the vertical extent of groundwater contamination in the alluvium aquifer. Three bedrock wells will be at the FEMA Storage Facility. Well locations and screen intervals will be recommended to EPA in a Technical Memorandum after the groundwater screening survey is completed.

Sampling design and rationale:

Alluvium Aquifer Monitoring Wells

A total of 16 monitoring wells at 8 locations are proposed, including one background well location. Figure 6 shows the locations of monitoring wells. However, monitoring well locations and depths may be modified based on evaluation of the groundwater screening survey data. It is assumed that wells will be installed in pairs consisting of a deep and a shallow well. This will provide a means to define the vertical boundaries of groundwater contamination. Due to the varying depth of the alluvium aquifer, it is estimated that six shallow wells will be drilled to a depth of 50 feet bgs and that two shallow wells will be drilled to a depth of 30 feet bgs. Six deep wells will be drilled to a depth of 100 feet bgs and two deep wells will be drilled to a depth of 70 feet bgs.

It is anticipated that monitoring wells will be installed using the hollow stem auger (HSA) drilling method. Eight-inch diameter boreholes will be drilled to the target depth. Monitoring wells will be constructed of 4-inch diameter schedule 40 PVC casing and 10 foot lengths of slotted PVC screen. It is assumed that wells in the alluvium will be single-cased. The annulus around the well screen will be backfilled with sand which will extend two-feet above the well screen. A 2-foot bentonite seal will be placed above the sand pack and the remaining annulus will be grouted to the surface. An 8-inch steel protective casing with a locking cap will be installed and a concrete collar will be poured around the well. The well screen slot size and the grade of filter sand will be determined based on the results of the lithologic sampling of the groundwater screening locations.

Split-spoon samples will be collected at 5-foot intervals from the surface to total depth in the deep well of the each well pair. The split spoon samples will be logged by the on site geologist. The lithologic information will be used to support development of the hydrogeologic framework and CSM for the site. It is important to identify the presence of significant clay layers, sand and gravel layers, and other geologic materials that may control or limit groundwater flow and contaminant transport in the aquifer. Split-spoon samples will be screened with a photoionization detector (PID) to identify contaminated zones within the borehole. The PID screening data will be used to refine placement of the well screen.

Bedrock Monitoring Wells

Three monitoring wells will be drilled into bedrock; one upgradient of the FEMA Storage Facility and two downgradient (Figure 6). It is anticipated that one bedrock monitoring well will be cored. The cored well will be drilled first and logged to identify potential water bearing zones in the bedrock. The three bedrock wells will be installed approximately 30 feet into the bedrock or a total depth of approximately 60 feet bgs. Air rotary drilling will be used to drill through the unconsolidated materials and at least five feet into competent bedrock.

QAPP Worksheet #17k
Sampling Design and Rationale
Monitoring Well Installation and Development

■ Air Rotary Well Drilling

The unconsolidated soil portion of the borehole will be advanced from the ground surface to the bedrock using an air rotary drilling method to create a 12-inch diameter borehole. A 8-inch diameter carbon steel casing will be tightly sealed into competent bedrock surface using a cement/bentonite grout slurry. Upon installation of the outer steel casing, the core will be drilled (see below). After coring the borehole will be advanced through the bedrock using the air rotary with direct circulation drilling method to create a nominal 8-inch borehole. The on-site geologist will monitor and record the materials brought to the surface by the air rotary drilling methods.

■ Rock Coring Well Drilling

An NQ rock coring bit will be used to advance a nominal 3-inch diameter borehole to depth. Upon completion of the coring, the borehole will be reamed to provide a nominal 8-inch diameter borehole. The on-site geologist will log the rock core, place the core in a core box, and store the core box for future reference. The rock cores will either be transferred to a government archive or disposed of by the IDW subcontractor at the completion of the work assignment.

■ Bedrock Monitoring Well Installation

Upon completion of the borehole to the target depth, the well will be installed. The bedrock boreholes will be double cased. Monitoring wells will be constructed of 4-inch diameter schedule 40 PVC casing and 10- foot lengths of 0.10-inch slotted PVC screen. The annulus around the well screen will be backfilled with sand which will extend 2-feet above the well screen. A 2-foot bentonite seal will be placed above the sand pack and the remaining annulus will be grouted to the surface with cement/bentonite grout. A 10-inch steel protective casing with a locking cap will be installed and a concrete collar will be poured around the well.

QAPP Worksheet #17k Sampling Design and Rationale Monitoring Well Installation and Development

Monitoring Well Development

Monitoring well installation will not be considered complete until the wells have been fully developed. Monitoring well development will be performed to remove silt and well construction materials from the well and sand pack and to provide a good hydraulic connection between the well and the aquifer materials. Turbidity, pH, temperature, conductivity, and dissolved oxygen will be monitored during development. Development will continue until all parameters have stabilized (within 10 percent for successive measurements) and the water is clear.

IDW Management

Drill cuttings and water from drilling operations will be containerized at the drilling location and transported by the drilling subcontractor to a central waste storage area. Liquid wastes will be transferred to a 21,000 gallon Baker tank and drill cuttings will be transferred to 20 cubic yard roll-off containers for subsequent sampling, characterization, and disposal by CDM's IDW subcontractor.

Field procedures for this activity are detailed in Appendix B.

- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 3-5 Lithologic Logging
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-3 Well Development and Purging, with a RAC II clarification, Section 5.1 Well Development
- TSOP 4-4 Design and Installation of Monitoring Wells in Aquifers (or manufacturer's specifications)
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

Analytical groups/concentration: No chemical analysis will occur during monitoring well installation

QAPP Worksheet #17k
Sampling Design and Rationale
Monitoring Well Installation and Development

Sampling locations: Figure 6 shows the monitoring well locations.

Number of samples/frequency: No samples will be collected during installation.

QAPP Worksheet #17I Sampling Design and Rationale Monitoring Well and Public Supply Well Sampling

Describe and provide a rationale for choosing the sampling approach: The monitoring wells will provide analytical data to determine the nature and extent of the groundwater contamination. Analytical data from groundwater sampling will be used to support preparation of the RI, HHRA, and FS reports.

Sampling design and rationale: Two rounds of groundwater samples will be collected from the 19 monitoring wells installed during the RI and the four Maunabo public supply wells. A total of 46 groundwater samples will be collected; 23 samples during each round. A minimum of two weeks will elapse between well development and groundwater sample collection. A minimum of three months will elapse between Round 1 and Round 2. Synoptic water level measurements will be collected from all monitoring wells prior to sampling. Monitoring wells will be purged with a Grundfos Rediflow 2 submersible pump and sampled following the site-specific low-flow, minimal drawdown sampling procedure which follow the EPA SOP "Ground Water Sampling Procedure, Low Stress (Low Flow) Purging and Sampling (EPA 1998).

The Maunabo Public Supply Wells will be sampled for residential water as described on TSOP 1-9. The well sample will be collected from the outlet located closest to the well head that have not undergone filtering or treatment. The outlet should run for a minimum of 5 minutes to purge the service line. After purging, the samples will be collected directly from the outlet with a low and smooth flow rate to reduce aeration.

The samples will be analyzed on-site for ferrous iron using the HACH method detailed in Appendix C and for the chemicals shown in Table 2.

Field procedures for this activity are detailed in

- Appendix A Site-Specific Low Flow Groundwater Purging and Sampling Procedure
- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-6 Water Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- TSOP 1-9 Tap Water Sampling
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures
- Appendix C Ferrous Iron Procedure

QAPP Worksheet #17I Sampling Design and Rationale Monitoring Well Sampling

Analytical groups/concentration: Groundwater and public supply well samples will be analyzed for trace level VOCs, TCL SVOCs, pesticides/PCBs, and TAL inorganics. To support evaluation of natural attenuation of VOCs in groundwater, samples will be analyzed for the following parameters: chloride, methane, ethane, ethene, nitrate/nitrite, sulfate, sulfide, ferrous iron, and TOC. Samples will also be analyzed for water quality parameters including TSS, TDS, alkalinity, ammonia, hardness, and TKN, DO, Eh, turbidity, pH, temperature, ferrous iron and conductivity. Table 2 shows the monitoring well sampling program.

Sampling locations: Figure 6 shows the monitoring well locations.

Number of samples/frequency: Two rounds of groundwater samples will be collected from the 19 monitoring wells installed during the RI and the four Maunabo public supply wells. A total of 46 groundwater samples will be collected; 23 samples during each round. A minimum of two weeks will elapse between well development and groundwater sample collection. A minimum of three months will elapse between Round 1 and Round 2.

Sample naming is detailed on Worksheet #26.

QAPP Worksheet #17m Sampling Design and Rationale Groundwater/Surface Water Interaction Evaluation

Describe and provide a rationale for choosing the sampling approach: The objective of the groundwater/surface water interaction investigation is to assess interaction between these two media in the Rio Maunabo. Discharge of contaminated groundwater to surface water has implications for the evaluation of human health and ecological risk.

Sampling design and rationale: Current information is insufficient to evaluate the locations of contaminated groundwater discharge to surface water. The groundwater/surface water interaction will be evaluated in the Rio Maunabo. A staff gauge and five temporary drive-point piezometers will be installed in the streambed of the Rio Maunabo. The surface water, sediment, and groundwater/surface water interaction temporary piezometer sample locations are shown on Figure 7. The staff gauge will consist of a calibrated scale affixed to a steel rod driven into the streambed. The top of the staff gauge will be surveyed so that water level measurements can be referenced to a known datum. The temporary piezometers will consist of a drive-point screen 6-12 inches in length attached to a stainless steel pipe. The screen will be driven 3 to 4 feet into the streambed. At each location, measurements will be taken of the water level inside the piezometer and the water level of the stream. Both measurements will be referenced to the same location at the top of the piezometer. The elevation and location of the top of each piezometer will be surveyed.

Field procedures for this activity are detailed in the SOPs in Appendix B:

- TSOP 1-6 Water Level Measurement
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- Worksheet 17c Decontamination Procedures

Analytical groups/concentration: No samples will be collected for chemical analysis.

**QAPP Worksheet #17m
Sampling Design and Rationale
Groundwater/Surface Water Interaction Evaluation**

Sampling locations: Temporary piezometers will be installed at 5 locations in the bed of Rio Maunabo. The locations of the temporary piezometers are shown in Figure 7.

Number of samples/frequency: No samples will be collected.

QAPP Worksheet #17n
Sampling Design and Rationale
Surface Water, Groundwater Seepage, and Sediment Sampling

Describe and provide a rationale for choosing the sampling approach: As part of the investigation, surface water, groundwater seepage, and sediment samples are co-located and will be collected to characterize the nature and extent of contamination in order to support RI and ecological and human health risk assessments.

Sampling design and rationale: Since the site is currently identified as a groundwater plume with an unknown source, the major pathway for contamination of surface water and sediment is via discharge of contaminated groundwater to the Rio Maunabo. Accordingly, the surface water, groundwater seepage, and sediment program focus on those areas where contaminated groundwater is expected to discharge. Sediment samples will be collected from a depth of 0 to 6 inches below the sediment surface. Surface water samples will be collected directly into the sample containers. Temporary piezometer groundwater seepage samples will be collected with a bailer. A minimum of three volumes of water will be purged from each piezometer prior to sampling. After the bailed samples are taken, diffusion bags will be placed inside the piezometers to collect VOCs for a time-weighted average concentration over two weeks.

Field procedures for this activity are detailed in the SOPs in Appendix B:

- TSOP 1-1 Surface Water Sampling, Section 5.2 Shallow Surface Water Sample Collection
- TSOP 1-2 Sample Custody, with a RAC II clarification
- TSOP 1-5 Groundwater Sampling Using Bailers
- TSOP 1-10 Field Measurement of Organic Vapors, Section 5.1 Direct Reading Measurement
- TSOP 1-11 Sediment/Sludge Sampling, with a RAC II clarification, Section 5.2 Sediment and Sludge Collection from Shallow Waters
- TSOP 2-1 Packing and Shipping of Environmental Samples, with a RAC II clarification, Section 4
- TSOP 2-2 Guide to Handling Investigation Derived Waste
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation
- TSOP 4-5 Field Equipment Decontamination at Non-Radioactive Sites, with a RAC II clarification
- PSOP 1 Diffusion Bag Sampling
- Worksheet 17c Decontamination Procedures

QAPP Worksheet #17n
Sampling Design and Rationale
Surface Water, Groundwater Seepage, and Sediment Sampling

Analytical groups/concentrations: Surface water and groundwater seepage samples will be analyzed for trace VOCs, TCL SVOCs, pesticides/PCBs, and TAL metals, cyanide, alkalinity, ammonia, hardness, nitrate/nitrite, TKN, sulfate, sulfide, chloride, TOC, TDS, and TSS. In addition, CDM will collect field measurements including temperature, conductivity, pH, turbidity, DO, and redox potential (as Eh) at each surface water and groundwater seepage sampling location.

Sediment samples will be analyzed for full TCL/TAL parameters, grain size, pH, and TOC.

Refer to Worksheets # 18 and # 30 and Table 2.

Sampling locations: Surface water, groundwater seepage, and sediment sample locations are shown on Figure 7.

Number of samples/frequency: One round of surface water and sediment samples will be collected at seven locations in the Rio Maunabo. Surface water and sediment samples will be collected from the stream and streambed, respectively. In addition, one groundwater seepage sample will be collected from each of the five temporary piezometers installed as part of the groundwater/surface water interaction investigation. The surface water, sediments, and groundwater seepage sample locations are shown on Figure 7. Specific locations of the surface water and sediment samples in the field will be based on actual field conditions (such as amount of sediment available) and biased towards sedimentation locations (such as the slower flowing portions or the inside of stream bends, where lower flow velocities promote sediment deposition).

Sediment samples will be collected from a depth of 0 to 6 inches.

Sample naming is detailed on Worksheet # 26.

QAPP Worksheet #17o
Sampling Design and Rationale
Sub-Slab and Indoor Air Samples (Optional)

Describe and provide a rationale for choosing the sampling approach: Sub-slab and indoor air samples will be collected to determine the extent of air contamination and evaluate potential human risks. There is a potential for VOC vapors from the groundwater plume to migrate to structures above the plume and affect indoor air quality. Vapor intrusion is assessed by collecting sub-slab air samples (below basements or foundation slabs) and air samples from interior spaces of residences or other structures.

Sampling design and rationale: Currently, information about the depth and lateral extent of the plume and the nature of materials between the groundwater plume and the surface are not known. The location of the contaminant source or sources is currently unknown and the specific contaminants to target for sub-slab and vapor sampling have not been defined. Sub-slab and indoor air sampling are considered to be optional and will be performed only with EPA's approval.

CDM will evaluate the distribution of VOCs in groundwater based on the groundwater screening survey and monitoring well data. If VOCs are present in groundwater beneath buildings or soil in the source area, CDM will prepare a letter report defining the estimated boundaries of the groundwater contamination and identifying potentially impacted residences or buildings. The letter report will recommend locations for sub-slab and indoor air sampling. CDM will discuss the recommendations with EPA and upon EPA's approval, will conduct sub-slab sampling at the targeted building(s). Indoor air sampling will be conducted if the sub-slab sampling results indicate the potential for migration of VOCs to indoor air.

Installation of sub-slab probes and air sampling will be conducted in accordance with the USEPA Guidance for Evaluation of the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (EPA 2002)

Sub-slab sampling will require installation of sampling ports through the slabs on the buildings. A 1.5 inch diameter hole will be drilled through the concrete slab so a stainless steel tube can be pushed one foot into the material below the slab for vapor testing. One air canister will be placed in ground floor of each building for 24 hours. Upon retrieval, the air samples will be shipped to the laboratory for VOC analysis.

QAPP Worksheet #17o
Sampling Design and Rationale
Sub-Slab and Indoor Air Samples (Optional)

Field procedures for this activity are detailed in the SOPs in Appendix B:

- TSOP 1-8 VOC Air Sampling Using USEPA Method TO-15 With SUMMA® Canister
- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation

Analytical groups/concentrations: VOC Analysis using EPA Method TO-15 with SUMMA canisters. Specific VOC compounds will be selected based on the results of the groundwater screening and monitoring well sampling.

Sampling locations: Indoor air samples will be collected from the main living floor of the home if VOCs are detected in the initial sub-slab samples. In order to prevent interference, crawl space vents (if present) will be closed prior to conducting indoor air sampling. The field team will survey the area for any household products or conditions that could affect the indoor air sampling results. For the concurrent sampling, one air canister will be placed in the main living floor of the home and one canister will monitor sub-slab vapors for a period of 24 hours. Ambient air samples will be collected upwind of the sampling area, concurrently with the indoor air samples.

Number of samples/frequency: It is assumed that four initial sub-slab samples and four concurrent sub-slab/indoor air samples (twelve samples total) will be collected from residences or buildings in Maunabo. The concurrent sub-slab/indoor air samples will be collected only if VOCs are detected in the initial sub-slab samples. If indoor air sampling is conducted, it is estimated that one ambient air sample will be collected in conjunction with the indoor air sampling (thirteen samples total).

QAPP Worksheet #17p Sampling Design and Rationale Ecological Field Investigation

Describe and provide a rationale for choosing the sampling approach: An ecological characterization of the site will be conducted to describe existing conditions relative to vegetation community structure, wildlife utilization, and sensitive resources such as surface waters and wetlands.

Sampling design and rationale: Based on the current understanding of the site contamination and the existing CSM, much of the contamination occurs in groundwater and is not available to ecological receptors. Potential impact to ecological receptors occurs only in areas where groundwater discharges to water bodies, which will be determined during the field investigation. In addition, ecological receptors may also be exposed to the contaminants in surface water and sediment of the Rio Maunabo.

The ecological characterization will be conducted at the Rio Maunabo and will be limited to these areas where potential groundwater discharge may occur. It will consist of a review of existing information, an ecological field investigation, and identification of threatened/endangered species and critical habitats.

Critical habitat is defined in the Endangered Species Act as:

(i) the specific areas within the geographical area currently occupied by a species, at the time it is listed in accordance with Section 4 of the Act, on which are found those physical or biological features (a) essential to the conservation of the species, and (b) which may require special management considerations or protection, and

(ii) specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Secretary that such areas are essential for the conservation of the species.

Habitat conditions will be visually inspected by walking the site and recording observations of species composition and relative diversity and abundance, habitat association, and surface water conditions. Field observations will be recorded in logbooks and photographs will be taken to record both representative and unusual site conditions that would influence conclusions regarding potential contamination pathways, food chain effects, receptor identification, and risks to floral and faunal communities.

QAPP Worksheet #17p Sampling Design and Rationale Ecological Field Investigation

The following information will be gathered during the field survey:

- General aquatic habitat conditions (e.g., water velocity, bottom substrate, channel width, channel depth, and extent of bank vegetation cover) along the water bodies. The Physical Characterization/Water Quality Field Data Sheet and the Habitat Assessment Field Data Sheet included in EPA's Rapid Bioassessment Protocols for Use in Streams and Rivers may be used as tools to complete the characterization of the aquatic habitats.
- Kick nets and/or seines may be used to assess aquatic ecosystems and their inhabitants.
- Vegetation community/cover types and observed vegetative species makeup of each community, including dominant species and general observation of abundance and diversity within each cover type, at and in areas related to the site.
- Wildlife use observations including wildlife habitats, species, wildlife concentrations areas, and habitat use activities.
- General surficial soil conditions.
- Indications of environmental stress that could be related to site contaminants.

An ecological description will be prepared for the RI report and SLERA that discusses the vegetative communities, wildlife habitats, suspected surface water drainage pathways, and observed areas of environmental stress or disturbance. The following information will also be prepared and presented: observed potential surficial migration pathways; vegetation communities and composition; observed terrestrial and aquatic wildlife habitats; observed and expected wildlife utilization of the site; potential occurrence of state and federal threatened, endangered, or rare species and critical habitats; and observed ecological impairments.

Field procedures for this activity are detailed in the SOPs in Appendix B:

- TSOP 4-1 Field Logbook Content and Control, with a RAC II clarification
- TSOP 4-2 Photographic Documentation of Field Activities, Sections 5.2.2 General Guidelines for Still Photography and 5.2.4 Photographic Documentation

Analytical groups/concentrations: No samples will be collected for chemical analysis.

Sampling locations: Not applicable.

Number of samples/frequency: Not applicable.

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ ID Number	Matrix	Depth (feet)	Analytical Group	Concentration Level	Number Samples (Identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
Municipal Public Supply Wells (see Figure 5)	Groundwater	Maunabo 1 = 90 ft Maunabo 2 = 100 ft Maunabo 3 = 84 ft Maunabo 4 = 92 ft	Trace VOCs, TCL SVOCs and Pest/PCBs, TAL metals, cyanide, DO, Eh, Turb, pH, Cond, Temp	Trace	4 x 2 rounds (1 duplicate)	TSOP 1-9	See Worksheet #17I
Groundwater Screening Samples (see Figure 5)	Groundwater	Transects 1, 2, and 4 = 130 ft Transect 3 = 70 ft	Trace VOCs (<1 µg/L) (24-hour turnaround) DO, Eh, Turb, pH, Cond, Temp	Low	282 (4 transects) (14 duplicates) 52 contingent samples (3 duplicates)	TSOP 3-1	See Worksheet #17d
Monitoring Well Sampling (see Figure 6)	Groundwater	TBD based on groundwater screening	Trace VOCs, TCL SVOCs, Pest/PCBs, TAL metals, cyanide, chloride, methane/ethane/ ethene, nitrate, nitrite, sulfate, sulfide, TOC, ferrous iron, TSS, TDS, alkalinity, ammonia, hardness, TKN	Trace	19 wells (2 duplicates) x 2 rounds	Low flow sampling method (Appendix A)	See Worksheet #17I

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ ID Number	Matrix	Depth (feet)	Analytical Group	Concentration Level	Number Samples (Identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
Surface Water (see Figure 7)	Water	1-3.3	TCL VOCs, TCL SVOCs, pest/PCBs, TAL metals, mercury, cyanide, alkalinity, ammonia, chloride, nitrate/ nitrite, sulfate, sulfide, TOC, TSS, TDS, hardness, TKN	Low	7 (1 duplicate)	TSOP 1-1, Section 5.2	See Worksheet #17n
Sediment (see Figure 7)	Sediment	0-6 inches	TCL VOCs, SVOCs, Pest/PCBs, TAL metals, mercury, cyanide, pH, grain size, TOC	Low	7 (1 duplicate)	TSOP 1-11, Section 5.2	See Worksheet #17n
Soil (contingent)	Soil	SS = 0-1 SB = 4 intervals (estimated 3-4 foot cores per location)	TCL VOCs, SVOCs, Pest/PCBs, pH, TOC, grain size	Low	6 surface soil 18 soil borings (1 duplicate)	TSOP 1-3, TSOP 1-4	See Worksheet #17f

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ ID Number	Matrix	Depth (feet)	Analytical Group	Concentration Level	Number Samples (Identify field duplicates)	Sampling SOP Reference	Rationale for Sampling Location
Groundwater Seepage Samples (see Figure 7)	Aqueous	6 to 12 inch length screen positioned 3 to 4 feet below the streambed	Trace VOCs TCL SVOCs, pest/PCBs, TAL metals, TKN cyanide, alkalinity, ammonia, chloride, nitrate/ nitrite, sulfate, sulfide, TOC, pH, TSS, TDS, hardness	Low	5 (one sample per piezometer)	TSOP 1-5	See Worksheet #17n
Diffusion Bag Samples (see Figure 7)	Aqueous	Same as groundwater seepage sample (above)	Trace VOCs	Low	5 (one sample per piezometer)	PSOP-1	See Worksheet #17n
Indoor Air Samples	Air	NA	Selected VOCs based on groundwater screening and monitoring well data	Low	13 (1 duplicate)	TSOP 1-8	See Worksheet #17o
Sub-Slab Air Samples	Air	1 ft	Selected VOCs based on groundwater screening and monitoring well data	Low	13 (1 duplicate)	TSOP 1-8	See Worksheet #17o

Note: See Table 2 for sampling program summary

QAPP Worksheet #19
Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical/Preparation Method/SOP Reference¹	Minimum Sample Volume	Containers^{2,3} (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time⁴ (preparation/ analysis)
Aqueous	VOCs (trace)	Trace	SOM01.2	80 ml	3-40 ml vials with Teflon septum	HCl to pH<2; Cool to 4 degrees C	10 days preserved-VTSR (14 days technical)
Aqueous	VOCs (24 hour TAT)	Trace	SOM01.2	80 ml	3-40 ml vials with Teflon septum	HCl to pH<2; Cool to 4 degrees C	24 hours (TAT) (14 days technical)
Aqueous	TCL SVOCs	Low	SOM01.2	1 liter	2-1 liter amber bottles with Teflon lined caps	Cool to 4 degrees C	5 days to extraction, 40 days to analysis-VTSR (7/40 technical)
Aqueous	TCL Pesticides	Low	SOM01.2	1 liter	2-1 liter amber bottles with Teflon lined caps	Cool to 4 degrees C	5 days to extraction, 40 days to analysis-VTSR (7/40 technical)
Aqueous	TCL PCBs	Low	SOM01.2	1 liter	2-1 liter amber bottles with Teflon lined caps	Cool to 4 degrees C	5 days to extraction, 40 days to analysis-VTSR (7/40 technical)
Aqueous	TAL metals, & mercury	Low	ILM05.4 (ICP-AES, & ICP-MS)	2 liters (ICP-AES & ICP-MS)	2-1 liter polyethylene bottles	HNO ₃ to pH <2; Cool to 4 degrees C	178 days (180 technical); Hg: 26 days-VTSR (28 technical)
Aqueous	TAL cyanide	Low	ILM05.4	1 liter	1-1 liter polyethylene bottles	c to pH>12; Cool to 4 degrees C	12 days-VTSR (14 technical)
Aqueous	alkalinity	Low	310.1	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	14 days
Aqueous	ammonia	Low	350.1/350.2	500 ml	1-1 liter polyethylene bottle	Cool to 4 degrees C	28 days
Aqueous	ferrous iron	Low	HACH 8146	25 ml	1 polyethylene bottle	Cool to 4 degrees C	24 hours
Aqueous	hardness	Low	130.1/130.2 or ILM05.4/200.7 by calculation	100 ml	1-250 polyethylene bottle	HNO ₃ to pH<2; Cool to 4 degrees C	6 months
Aqueous	chloride	Low	325.1 or 300	50 ml	1-125 ml polyethylene bottle	Cool to 4 degrees C	28 days
Aqueous	methane/ethane/ethene	Low	RSK 175	40 ml	3-40 ml vials with Teflon septum	HCl to pH<2; Cool to 4 degrees C	7 days
Aqueous	nitrate	Low	352.1 or 300	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	48 hours

QAPP Worksheet #19
Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical/Preparation Method/SOP Reference ¹	Minimum Sample Volume	Containers ^{2,3} (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time ⁴ (preparation/ analysis)
Aqueous	nitrite	Low	354.1 or 300	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	48 hours
Aqueous	sulfate	Low	375.3/375.4 or 300	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	28 days
Aqueous	sulfide	Low	376.2 or 376.1	25 ml	1-1 liter polyethylene bottle	NaOH to pH 9 plus zinc acetate	7 days or 24 hours if zinc acetate is not used
Aqueous	TDS	Low	160.1	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	7 days
Aqueous	TKN	Low	351.2 or 351.4	500 ml	1-1 liter polyethylene bottle	H ₂ SO ₄ to pH<2; Cool to 4 degrees C	48 hours to extraction; 28 days to analysis
Aqueous	TOC	Low	415.1 or 415.2	50 ml	1-250 ml amber glass (protect from light)	H ₂ SO ₄ to pH<2; Cool to 4 degrees C	28 days
Aqueous	TSS	Low	160.2	100 ml	1-250 ml polyethylene bottle	Cool to 4 degrees C	7 days
Soil/ sediment	TCL VOCs	Low	SOM01.2	5 g each	3-40 ml closed system vials with spin bar; 1-2oz glass jar for moisture (no head space)	Cool to 4 degrees C	10 days-VTSR (14 days technical) Samples frozen within 48 hours 48 hours for the moisture jar
	Moisture			40 ml	1-40 ml glass jar/PTFE lined septa/open top screw caps (no headspace)		
Soil/ sediment	TCL SVOCs	Low	SOM01.2	Fill to capacity	1-8 oz jar	Cool to 4 degrees C	10 days to extraction; 40 days to analyze (14/40 technical)
Soil/ sediment	TCL Pesticides	Low	SOM01.2		1-8 oz jar	Cool to 4 degrees C	10 days to extraction; 40 days to analyze (14/40 technical)
Soil/ sediment	TCL PCBs	Low	SOM01.2		1-8 oz jar	Cool to 4 degrees C	10 days to extraction; 40 days to analyze (14/40 technical)
Soil/ sediment	TAL metals & mercury	Low	ILM05.4	Fill to capacity	1-8 oz jar	Cool to 4 degrees C	178 days (180 technical); Hg: 26 days (28 technical)



QAPP Worksheet #19 Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical/Preparation Method/SOP Reference ¹	Minimum Sample Volume	Containers ^{2,3} (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time ⁴ (preparation/ analysis)
Soil/ sediment	TAL cyanide	Low	ILM05.4		1-8 oz jar	Cool to 4 degrees C	12 days VTSR (14 technical)
Soil/ sediment	pH	Low	SW-846 9045C		1-8 oz jar	None	24 hours
Soil/ sediment	grain size	Low	ASTM D421-85 ASTM D422-63	500 g	1-8 oz jar	Cool to 4 degrees C	None
Soil/ sediment	TOC	Low	Lloyd Kahn	10 g	1-8 oz jar	Cool to 4 degrees C	14 days
Air	VOC	Low	TO-15	6 liters	1 SUMMA™ canister	NA	30 days

ASTM American Society for Testing Materials
C Celsius
H₂SO₄ Sulfuric Acid
HCl Hydrochloric Acid
HNO₃ Nitric Acid
mL milliliter
NaOH Sodium Hydroxide
PTFE Polytetrafluoroethylene
VOA Volatile organic analysis
VTSR Verified Days to Sample Receipt

1. SOP reference numbers are laboratory specific. This information is maintained by EPA and is not available to EPA contractors.

2. Aqueous VOC vials must be filled to capacity with no headspace or air bubbles.

3. No additional volume is required for MS/MSD analyses for VOC and SVOC analysis.

The field team will consolidate the sample bottles dependent on the type of preservation and laboratories assigned to the wet chemistry analyses.

4. Holding times are from date of collection except for TCL VOC (trace), TCL and TAL analyses. These analyses holding times are from the verified time of sample receipt (VTSR).

For Worksheet #19 DESA requirements are included in Appendix G.

QAPP Worksheet #20
Field Quality Control Sample Summary Table

Field Task	Matrix	Analytical Parameters	Environmental Samples	Field Duplicates	MS/MSDs or MS/D ^{1,4}	Field Blanks ²	Trip Blanks ³
Groundwater Screening Sampling	GW	Trace VOCs - 24 hour TAT	334	17	0	22	22
Municipal Public Supply and New Monitoring Well Sampling (2 Rounds)	GW	Trace VOCs	46	3	0	12	12
		TCL SVOCs	46	3	0	12	0
		TCL Pesticides, PCBs, TAL Metals, Cyanide and Mercury	46	3	3	12	0
		Chloride, nitrate, nitrite, sulfate, sulfide, TOC, ferrous iron, TSS, TDS, ammonia, hardness, and TKN	46	3	2 ⁵	12	0
		methane, ethane, ethene	46	3	2 ⁵	12	12
Surface Water Sampling	SW	Trace VOCs	7	1	0	1	1
		TCL SVOCs	7	1	0	1	0
		TCL Pesticides, PCBs, TAL Metals, Cyanide and Mercury	7	1	1	1	0
		Alkalinity, ammonia, chloride, hardness, nitrate, nitrite, sulfate, sulfide, TOC, TSS, TDS, and TKN	7	1	1 ⁵	1	0
Soil Sampling	Soil	TCL VOCs, SVOCs	24	2	0	6	0
		TCL Pesticides, PCBs, TAL Metals, Cyanide and Mercury	24	2	2	6	0
		pH, TOC, grain size	24	2	2 ⁵	6	0
Air Sampling	Air	Selected VOCs based on groundwater screening and monitoring well data	13	1	0	0	0
Surface Water/Groundwater Interaction Sampling	Water	Trace VOCs - diffusion bags	5	1	1	1	1
Groundwater Seepage Sampling	Water	TCL Pesticides, PCBs, TAL Metals, Cyanide and Mercury	5	1	1	1	0
		Alkalinity, ammonia, chloride, hardness, nitrate, nitrite, sulfate, sulfide, TOC, TSS, TDS, and TKN	5	1	15	1	0
Sediment Sampling	Sediment	TCL VOC, SVOCs	7	1	0	1	0
		TCL Pesticides, PCBs, TAL Metals, Cyanide and Mercury	7	1	1	1	0
		pH, grain size, TOC	7	1	1 ⁵	0	0

Notes:

- 1 : Matrix Spike (MS)/Matrix Spike Duplicate (MSD) or MS/D for metals, mercury, and cyanide
- 2: Field blanks are collected at a frequency of 1 per day per decontamination event. The actual number of field blanks may be different due to timing of decontamination events and the number of days for sampling.
- 3: Trip blanks (for VOCs only) are collected at a frequency of 1 per day per cooler of VOCs
- 4: If using SOM01.2, MS/MSDs are not needed for VOCs and SVOCs

QAPP Worksheet #20

Field Quality Control Sample Summary Table

5: The numbers italicized in the MS/MSD column represent the requirement for a QC sample; they will be designated only.

D Duplicate
SVOC Semivolatile Organic Compound
TAL Target Analyte List
TCL Total Compound List
VOC Volatile Organic Compound
MEE Methane/ethane/ethene
TDS Total dissolved solids
TKN Total Kjeldahl nitrogen

TOC Total Organic Carbon
TSS Total suspended solids
LDL Low-Detection Limit
TAT Turnaround Time
GW Groundwater Sample
MW Monitoring Well
SW Surface Water
SD Sediment

QAPP Worksheet #21
Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
1-1	Surface Water Sampling, Rev. 6, 3/1/04, Section 5.2	CDM	Section 4 of TSOP Sample containers	N	
1-2	Sample Custody, Rev. 4, 10/10/04	CDM	NA	Y	-Sample tags are not required. -Forms II Lite generated COCs will be used. -Use waterproof ink for any handwritten labels.
1-3	Surface Soil Sampling, Rev. 5, 10/15/04	CDM	Section 4 of TSOP DPT Rig	Y	
1-4	Subsurface Soil Sampling, Rev. 5, 10/13/04	CDM	Section 4 of TSOP DPT Rig	Y	
1-5	Groundwater Sampling Using Bailers, Rev. 4, 12/31/04	CDM	Section 2 of TSOP Disposable Bailer and Cord	Y	
1-6	Water Level Measurement, Rev. 5, 12/31/04	CDM	Section 4 of TSOP Troll or equivalent	N	
1-8	Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA® Canister. Rev. 4, 3/1/04	CDM	Section 4 of TSOP SUMMA® Canister	N	
1-9	Tap Water Sampling, Rev. 2, 10/15/04	CDM	Section 4 of TSOP Sample containers	Y	
1-10	Field Measurement of Organic Vapors, Rev. 3, 3/1/04	CDM	Section 4 of TSOP Mini-RAE, LEL meter	N	
1-11	Sediment/Sludge Sampling, Rev. 6, 10/15/04	CDM	Section 4 of TSOP Spatulas, Hand-auger	Y	
2-1	Packing and Shipping of Environmental Samples, Rev. 3, 10/20/04	CDM	Section 1.3 of TSOP lists materials needed	Y	-Methanol will not be used. -Vermiculite shall not be used. -Metal cans will be used to collect medium level soil samples

QAPP Worksheet #21
Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
2-2	Guide to Handling Investigation – Derived Waste, Rev. 4, 3/1/04	CDM	NA	N	
3-1	Geoprobe Sampling, Rev. 4, 3/1/04	CDM	Section 4 of TSOP	N	
3-2	Topographic Survey, Rev. 5, 12/13/04	CDM	NA	N	
3-4	Geophysical Logging, Calibration , and Quality Control, Rev. 4, 3/1/2004	CDM	Gamma Logs Only	N	
3-5	Lithologic Logging, Rev. 6, 3/1/04	CDM	Section 4 of TSOP	Y	
3-6	Underground Facility Location, Rev. 0, 5/6/05	CDM	NA	N	
4-1	Field Logbook Content and Control, Rev. 3, 10/14/05	CDM	NA	Y	Logbook notes should include decon procedures used, descriptions of photos taken, problems encountered and notes of conversations with Project Engineer/PM/Project Geologist. Details of samples collected including CLP numbers and visual observations.
4-2	Photographic Documentation of Field Activities, Rev. 6, 3/1/04	CDM	Camera	N	
4-3	Well Development and Purging, Rev. 3, 10/14/05	CDM	Section 4 of TSOP YSI	Y	Water removed during evacuation should not be reintroduced into the well. Record water level in well, pumping flow rate, and the total volume of water purged.
4-4	Design & Installation of Monitoring Wells in Aquifers, Rev. 3, 10/14/05	CDM	See Worksheet 17h	N	
4-5	Field Equipment Decontamination at Nonradioactive Sites	CDM	Section 4 of TSOP	N	See Worksheet #17c -Use phthalate-free gloves
4-6	Hydraulic Conductivity Testing, Rev. 2, 12/31/04	CDM	Section 4 of TSOP	N	
4-8	Environmental Data Management	CDM	NA	N	See Worksheet #14
5-1	Control of Measurement and Test Equipment, Rev. 5, 12/31/04	CDM	NA	Y	Leased or rented equipment only to be used.
Worksheet 17C	Decontamination Procedures	CDM	See Worksheet 17c	N	

CDM

Final Quality Assurance Project Plan

R2-0000320

QAPP Worksheet #21
Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
PSOP 1	Passive Diffusion Bag Water Sampling	CDM	Passive diffusion bags	Y	Project Specific
Appendix D CDM-029A	Data Validation of Wet Chemistry Parameters, 7/01	CDM	NA	N	
Appendix A	Low Flow Groundwater Purging and Sampling Procedure	EPA 1998	NA	Y	CDM project modified

QAPP Worksheet #22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ¹
Mini - RAE photoionization detector (PID) Toxic Gas Monitor with 11.7 eV lamp	Calibration checked at the beginning and end of day	As needed in field; semi-annually by supplier	Measure known concentration of Isobutylene 100 ppm (calibration gas)	Upon receipt, Successful operation	Calibrate am, check pm	± 10% of the calibrated value	Manually zero meter or service as necessary and recalibrate	FTL	Manufacturers specifications
YSI 600XL Water Quality Checker	Calibrate at the beginning of the day and check calibration at the end of the day	Performed before shipment and as needed	Measure solutions with known values (National Institute for Standards and Technology (NIST) traceable buffers and conductivity calibration solutions)	Upon receipt, Successful operation	Daily, before each use	pH: ± 0.05 Specific Conductivity: ±5 micro Siemens (µS) DO ± 0.02 ppm Temp.: ±0.3°C	Recalibrate or service as necessary	FTL	Manufacturers specifications
Natural Gamma (Downhole Geophysics)	Calibrated by manufacturer	None	Measures gamma radiation	Upon receipt, Successful operation	As needed	0-100 kcps	Recalibrate or service as necessary	Field Geologist (FG)	Manufacturers specifications
Lower explosive limit (LEL)/O ₂ meter	Calibrated by manufacturer	Performed before shipment and as needed	Measures known concentration of pentane and percent of O ₂	Upon receipt, Successful operation	Calibrate am, check pm	+/- 0.5 ppm	Manually zero or service as necessary and recalibrate	FTL	Manufacturers specifications

QAPP Worksheet #22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ¹
La Mott Turbidity Meter Model 2020	Calibrate daily before each use	As needed	Measure solutions with known turbidity standards	Upon receipt, Successful operation	Daily prior to use	N/A (instrument zeroed)	Manually zero or service as necessary and recalibrate	FTL	Manufacturers specifications

¹Refer to the Project Sampling Standard Operating Procedure (SOP) References table (Worksheet #21).

**QAPP Worksheet #23
Analytical SOP References Table**

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
CLP Organic and Inorganic Methods						
SOM01.2	Multi-Media, Multi-Concentration, Organic Analytical Service for Superfund. EPA 2005.	Definitive	Trace VOC	Gas Chromatograph/Mass Spectrometer (GC/MS) (24 hr TAT)	DESA or CLP	N
			TCL VOC-soil	Purge and Trap - GC/MS		N
			TCL SVOCS	GC/MS		N
			TCL Pesticides	GC/MS		N
			TCL PCBs	GCMS with Electron Capture (ECD) detector		N
RSK 175 (2)	Analysis of Dissolved Methane, Ethane, and Ethene in Groundwater	Definitive	VOCs	GC	CDM subcontract lab	N
ILM05.4 (AES & MS)	Multi-Media, Multi-Concentration, Inorganic Analytical Service for Superfund. EPA 2004.	Definitive	Metals	ICP-Atomic Emission Spectrometer (AES) and ICP-MS	DESA or CLP	N
TAL metals, mercury, cyanide		Definitive	Mercury	Cold Vapor Atomic Absorption	DESA or CLP	N
			Cyanide	Distiller - Colorimeter		
Wet Chemistry Methods						
130.1, 130.2	MCAWW. Revised 1983	Definitive	Hardness	Colorimeter, automated or titrimetric	DESA or CDM subcontract lab	N
200.7	MCAWW. Revised 1983	Definitive	Hardness	ICP-Atomic Emission Spectrometer (AES)	DESA or CDM subcontract lab	N
160.1	MCAWW. Revised 1983	Definitive	TDS	Balance, oven	DESA or CDM subcontract lab	N
160.2	MCAWW. Revised 1983	Definitive	TSS	Balance, oven	DESA or CDM subcontract lab	N
300	MCAWW. Revised 1983	Definitive	Chloride, nitrate, nitrite & sulfate	Ion Chromatography	DESA or CDM subcontract lab	N

QAPP Worksheet #23
Analytical SOP References Table

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
310.1	Method for Chemical Analysis of Water and Wastes (MCAWW). Revised 1983	Definitive	Alkalinity	pH meter or electronic titrator	DESA or CDM subcontract laboratory	N
325.1	MCAWW. Revised 1983	Definitive	Chloride	Colorimeter, automated		N
352.1	MCAWW. Revised 1983	Definitive	Nitrate	Colorimeter		N
354.1	MCAWW. Revised 1983	Definitive	Nitrite	Colorimeter		N
350.1, 350.2	MCAWW. Revised 1983	Definitive	Ammonia	Colorimeter-automated, Titrimetric, Potentiometric (electrode)		N
351.2, 351.4	MCAWW. Revised 1983	Definitive	TKN	Colorimeter-automated, Titrimetric, Potentiometric (electrode)		N
375.3, 375.4	MCAWW. Revised 1983	Definitive	Sulfate	Gravimetric (balance, oven)/ Spectrophotometer		N
376.2, 376.1	MCAWW. Revised 1983	Definitive	Sulfide	Colorimeter		N
415.1, 415.2	MCAWW. Revised 1983	Definitive	TOC - aqueous	Balance, carbonaceous analyzer/ blender, Carbon analyzer		N
Soil and Field Analytical Methods						
SW-846 9045C	Test Methods for Evaluation Solid Waste Physical/Chemical Methods, EPA, SW-846, Third Edition revised May 1997. Final Updates, I, IIA, IIB, III, IIIA, & IIIB	Definitive	pH - soil	Balance, pH meter	DESA or CDM subcontract laboratory	N
Lloyd Kahn	Determination of TOC in Sediment, July 1998 and Attachment B, Supplemental Technical Direction and Additional QC Procedures.	Definitive	TOC - soil	Carbon analyzer (several models apply - see method, Sec.5)	DESA or CDM subcontract laboratory	N

CDM

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QAPP Worksheet #23
Analytical SOP References Table

Reference Number(1)	Title, Revision, Date, and/or No.	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Project Work Modified (Y/N)
ASTM D421-85	Standard Practice for Dry Preparation of Soil Samples. 2002	Definitive	Grain size	Sieves, hydrometer	DESA or CDM subcontract laboratory	N
ASTM D422-63	Standard Test Method for Particle-Size Analysis of Soils. 2002	Definitive	Grain size	Sieves, hydrometer	DESA or CDM subcontract laboratory	N
HACH 8146	HACH Test Kit - Phenanthroline Method (adapted from SM for Water and Wastewater)	Definitive	Ferrous Iron	Spectrophotometer model DR/890, 850 or 820	CDM field personnel	N
TSOP 1-10 and Manufacturer's Manual	Field Measurement of Organic Vapors / Manufacturer's Manual	Screening	VOC, oxygen, lower explosive limit, carbon monoxide, hydrogen sulfide	Multi-RAE Dual PID (Photoionization Detector) -Toxic Gas Monitor	CDM field personnel	N
Not Applicable	Manufacturer's Manual	Definitive	Turbidity	LaMotte Turbidity Meter, Model 2020	CDM field personnel	N
Not Applicable	Manufacturer's Manual	Definitive	pH-aqueous	YSI Water Quality Checker, Model 600 XL	CDM field personnel	N
			Oxidation-reduction Potential			N
			Dissolved Oxygen			N
			Specific Conductance Temperature			N
Air Analytical Methods						
TO-15	Determination of volatile organic compounds (VOCs) specially-prepared canisters	Definitive	Air VOC Vapors	GC/MS	EPA subcontract laboratory	N

CDM

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QAPP Worksheet #23

Analytical SOP References Table

Notes:

1. CLP laboratories SOPs are reviewed through EPA. DESA laboratory specific SOPs will apply and not these generic SOPs whenever the DESA laboratory is able to perform the analyses. CDM subcontract laboratory specific SOPs are not available at this stage since the Region II FASTAC Policy will be implemented for procuring laboratory services. If the DESA laboratory does not have capacity for these analyses, then a CDM basic ordering agreement (BOA) subcontractor laboratory will be selected.
2. Robert S. Kerr Environmental Research Laboratory Standard Operating Procedures
3. For non-RAS data, the ASC will submit the electronic "Analytical Services Tracking System (ANSETS) Data Requirement" form to the RSCC by the first day of each month for the previous month's sampling.

For Worksheet # 23 DESA requirements are included in Appendix G

**QAPP Worksheet #24
Analytical Instrument Calibration Table**

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA ¹	SOP Reference ²
Instruments used for EPA CLP analyses follow the calibration frequencies outlined in each method SOP.						
GC, GC/MS, GC/EC	Initial Calibration; 5 point standards	After instrument set up or when daily 12-hour calibration check fails	All target compounds, initial relative standard deviation (RSD) \leq 10% or 20% and R3 $>$ 0.995	Inspect system; correct problem; re-run failed calibration and any associated samples	Lab analyst / QA officer - (TBD)	TBD
	Continuing Calibration Verification (CCV)	Daily; every 12-hours of analysis	%D \leq 15%			
	Calibration Standards Verification	Each lot of standards	As per lab established control limits	Inspect system; correct problem; re-run standard and affected samples		
GC/MS	Tuning	Daily; every 12-hours of analysis	Response factors and relative response factors as method specified	Inspect system; correct problem; re-run standard and affected samples	Lab analyst / QA officer - TBD	TBD
CV-GAS	Calibration; 3 point standards	After instrument set up	$R^3 \geq 0.995$	Inspect system; correct problem	Lab analyst / QA officer - TBD	TBD
	Initial Calibration Verification (ICV)	Before sample analysis	80-120% recovery; source of standard separate from calibration standards	Do not analyze samples until problem is corrected	Lab analyst / QA officer - TBD	TBD
	Continuing Calibration Verification	10% or every 2 hours, whichever is more frequent	80-120% recovery	Inspect system, re-calibrate and rerun associated samples	Lab analyst / QA officer - TBD	TBD

**QAPP Worksheet #24
Analytical Instrument Calibration Table**

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA¹	SOP Reference²
ICP-AES	Calibration; 2 point standards (blank and standard)	Daily	90-110 % recovery	Re-calibrate instrument	Lab analyst / QA officer - TBD	TBD
ICP-AES	ICV	Before sample analysis	90-110% recovery; source of standard separate from calibration standards	Re-calibrate instrument; prepare fresh ICV standards; do not analyze samples until problem is corrected	Lab analyst / QA officer - TBD	TBD
ICP-AES	Reporting Limit Standard	After initial calibration verification standard	80-120% recovery or concentration \leq 30% difference (from true value)	Re-analyze failed standard	Lab analyst / QA officer - TBD	TBD
ICP-AES	CCV	Every 10 samples and at end of analytical sequence	90-110% recovery; source of standard separate from calibration standards	Re-check; re-calibrate and rerun all samples analyzed after last valid CCV	Lab analyst / QA officer - TBD	TBD
Total Organic Carbon Analyzer (soil)	Calibration and corrective action as per Manufacturer's instruction. No samples shall be analyzed if instrument calibration exceeds the acceptance criteria.				Lab analyst / QA officer - TBD	TBD
Colorimeter	Initial Calibration; 4 - 9 point standards	Every 3 months; every 6 months for method 300. or as per lab SOP	90-110 % recovery	Re-check; re-calibrate	Lab analyst / QA officer - TBD	TBD
	Calibration check (Cal Check)	Every 10 samples and at end of analytical run	80-120 % recovery	Re-check; re-calibrate and rerun all samples analyzed after last valid Cal Check	Lab analyst / QA officer - TBD	TBD

**QAPP Worksheet #24
Analytical Instrument Calibration Table**

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA¹	SOP Reference²
Infra red or UltraViolet Spectrophotometer	Initial Calibration; 5 point standards	Every 3 months or when other unresolved QC failure occurs	90-110 % recovery	Re-check; re-calibrate	Lab analyst / QA officer - TBD	TBD
	Calibration check	Every 10 samples and at end of analytical run	80-120 % recovery	Re-check; re-calibrate and rerun all samples analyzed after last valid cal check		
Ion Chromatography	Initial Calibration; 5 point standards	Every 12 hours of operation	90-110 % recovery	Find the problem and re-calibrate	Lab analyst / QA officer - TBD	TBD
Ion Chromatography	Calibration check	Every 10 samples and at end of analytical run	90-110 % recovery	Re-check; re-calibrate and rerun all samples analyzed after last valid cal check	Lab analyst / QA officer - TBD	TBD
pH meter	Daily buffer checks (2 point bracketing sample pH)	Before use/per batch; other checks as per rental company and manufacturer's recommendations	± 0.1 pH units or ± 0.05 pH units	Recheck; replace buffer solutions and recheck. If still fails perform instrument check or place out of service	CDM – FTL Lab analyst / QA officer - TBD	TBD
Thermometer	Calibration	Quarterly; serviced annually	See instrument manual	Replace defective thermometer	Lab analyst / QA officer - TBD	TBD
Balance	Calibration verification	Daily - before use	See instrument manual	Troubleshoot as per equipment manual/call for repair	Lab analyst / QA officer - TBD	TBD
	Mass check	Daily - before use	See instrument manual			TBD

**QAPP Worksheet #24
Analytical Instrument Calibration Table**

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA¹	SOP Reference²
	Temperature check	Annually	± 2°C			
Oven	Serviced annually as per Manufacturer's instruction				Lab analyst / QA officer - TBD	TBD

Notes:

1. The FASTAC decision process will be used for procuring laboratory services. CLP, DESA and CDM subcontract laboratory's calibration and/or method SOPs will be utilized to meet calibration criteria. Specific instrument information (Manufacturer and model) is not available at this time.
 2. To be determined (TBD) - Reference SOP depends on the laboratory assignment. EPA maintains the CLP laboratory SOP information. If a subcontract laboratory is needed, CDM will submit their SOP as a field change request.
 3. R represents the correlation coefficient
- For Worksheet # 24 DESA requirements are included in Appendix G.

QAPP Worksheet #25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ¹
Analytical instrument maintenance, testing and inspection information and availability of spare parts are not available since the FASTAC decision process will be utilized for analytical services.								
Information is provided in CDM BOA subcontract laboratories' QA Manuals. BOA laboratory to be utilized (if DESA is not available) not determined at this time. Maintenance, testing and inspection frequencies are documented in the BOA laboratories SOPs								

¹Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

For Worksheet #25 DESA requirements are included in Appendix G.

QAPP Worksheet #26 Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT: CDM TSOP 1-2, Sample Custody and TSOP 2-1, Packaging and Shipping of Environmental Samples apply

Sample Collection (Personnel/Organization): CDM will collect all samples under the supervision of the FTL. Sample numbers will be assigned as described below.

A coding system will be used to identify each sample collected during the field investigation phase of the project. This coding system will provide a tracking record to allow retrieval of information about a particular sample and ensure that each sample is uniquely identified.

Each sample is identified by a unique code which indicates the sample type, sample number, and, in some cases, sample depth or address. A sample numbering system is described below which provides a unique identifier for all samples that will be collected during the site field investigation.

Groundwater Screening Survey - The screening survey includes 3 transects (T-1 through T-4). Drilling locations along each transect are lettered alphabetically starting with A on the West. Samples will be designated by depth at each lettered drilling location. Example: T1-A-10 designates the sample on transect T1, location A, 10 feet bgs in depth.

Municipal Public Supply Wells – Four Maunabo supply wells will be sampled at two different sampling rounds for a total of 8 samples. Samples will be designated by the well name and round number. Example: Maunabo 1- R1 represents the groundwater sample from the Maunabo 1 well collected during Round 1.

Source Soil Samples (optional) – Source soil sampling is considered optional and will be performed only with EPA's approval. Six soil borings will be drilled with one surface soil and three samples collected at 4-foot intervals. Location of the soil borings will be determined in the field. Surface soil samples will be designated as SS-01 through SS-06. Borings will be designated as SB-01 through SB-18, with SB meaning "soil boring". Samples at each boring will be labeled A, B, or C, with A representing the shallowest sample collected. Sample depths will be recorded in the field logbook and on the boring logs. Example: SB-05-C designates the deepest sample from boring SB-05.

Monitoring Wells - An estimated 19 monitoring wells will be installed at the site. Sixteen wells will be installed in pairs and three wells will be installed in bedrock. Wells in pair will be labeled MW-01 through MW-8. The shallow well in the couplet will be given the letter "S" and the deeper well pairs will be given the letter "D". The three bedrock wells will use the letter "B", and be called i.e. MW-1B. Two rounds of samples will be collected from the monitoring wells; round one will be designated R1 and round two will be R2. Example: MW-8S designates the shallow monitoring well in couplet number 8. MW-8S-R1 represents the round one sample from monitoring well MW-8S.

QAPP Worksheet #26 Sample Handling System

Groundwater Seepage Samples – Five groundwater seepage samples will be collected from temporary piezometers installed as part of the groundwater/surface water interaction investigation. The location of the samples is shown in Figure 7. Sample designations will be GS–XX.

Surface Water/Sediment Samples - All surface water and sediment samples will be co-located when possible. Seven surface water/sediment samples are anticipated during Round 1. Sample locations are shown in Figure 7. Sample designations will be SW-XX for surface water sample and SD-XX for the sediment sample.

Air Samples (optional) – Air sampling is considered optional and will be performed only with EPA's approval. Four initial sub-slab samples, four concurrent sub-slab/indoor air samples and 1 ambient air will be collected. Sample designations will be SU-XX for sub-slab, IA –XX for indoor air, and AA -XX for ambient air.

QC Sample Numbering System: Each duplicate sample will be submitted “blind” to the laboratory by using a different sample number than the associated environmental sample. The actual collection time will be recorded for both the environmental sample and its duplicate. Duplicate sample name will be recorded in the field log book.

Trip blanks will be numbered by using the prefix “TB” in front of the date as follows: TB040907 for April 9, 2007.

Field blanks, using the prefix “FB”, will be numbered similarly. An additional code will be added to denote the sampling event. A field blank collected on April 9, 2007, in association with soil sampling will be labeled as FB040907-SB.

Sample Labels: Sample bottles will be pre-labeled prior to sample collection. All pertinent sample information will be noted on the label including the sample identification number, date and time the sample was collected, the type of sample, initials of person collecting the sample, preservation used and the analysis for which that sample is being submitted. Sample labels will be generated using the CLP labeling system, FORMS II Lite. Sampler, date and time will be filled out with indelible ink on the sample labels or entered into the application. Labels will be filled out with indelible ink and protected with clear tape.

Sample Packaging (Personnel/Organization): Jose Reyes, CDM

Coordination of Shipment (Personnel/Organization): Jose Reyes, CDM

Type of Shipment/Carrier: Federal Express Priority Overnight Shipping

SAMPLE RECEIPT AND ANALYSIS

Sample Receipt (Personnel/Organization): Laboratory Sample Custodian - TBD as per FASTAC

Sample Custody and Storage (Personnel/Organization): CDM and TBD as per FASTAC

QAPP Worksheet #26
Sample Handling System

Sample Preparation (Personnel/Organization): TBD as per FASTAC
Sample Determinative Analysis (Personnel/Organization): TBD as per FASTAC
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): All samples will be shipped to CLP laboratory, DESA or CDM subcontractor on the day of collection via priority overnight (Fedex). Samples may be hand delivered/courier depending on laboratory location. On-site tests will be performed same day.
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Refer to Worksheet #19 for holding time requirements.
Biological Sample Storage (No. of days from sample collection): Not Applicable.
SAMPLE DISPOSAL
Personnel/Organization: Laboratory responsible for analysis will dispose of samples.
Number of Days from Analysis: 90 days.

For Worksheet #26 DESA requirements are included in Appendix G.

QAPP Worksheet #27 Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Packaging will be performed according to the EPA Contract Laboratory Program (CLP) Guidance for Field Samplers, Final (EPA 2004). To maintain a record of sample collection transfer between field personnel, shipment, and receipt by the laboratory, the applicable sample chain-of-custody paperwork (TSOP 1-2) is completed for each shipment (i.e., cooler) of packed sample bottles. The team member actually performing the sampling is personally responsible for the care and custody of the samples collected until they are transferred properly. The FTL will review all field sampling activities to confirm that proper custody procedures were followed during the field work.

All courier receipts and/or paperwork associated with the shipment of samples will serve as a custody record for the samples while they are in transit from the field to the laboratory. Custody seals should remain intact during this transfer.

When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them and courier personnel relinquishing them will be completed in the appropriate spaces on the chain-of-custody record. This will complete sample transfer.

Coolers are secured with nylon fiber tape and at least two custody seals are placed across cooler openings. Since custody forms are sealed inside the sample cooler and custody seals remain intact, commercial carriers are not required to sign the chain-of-custody form. Examples of custody seals are included in TSOP 1-2.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving them and courier personnel relinquishing them will be completed in the appropriate spaces on the chain-of-custody record. This will complete sample transfer.

It will be each laboratory's responsibility to maintain internal logbooks and records that provide a custody record throughout sample preparation and analysis. To track field samples through data handling, CDM will maintain photocopies of all chain-of-custody forms.

Sample Identification Procedures:

Refer to Worksheet #26.

Chain-of-custody Procedures:

CDM will follow TSOP 1-2, Sample Custody, for chain-of-custody procedures.

For Worksheet #27 DESA requirements are included in Appendix G.

QAPP Worksheet #28 QC Samples Table

QAPP Worksheet #28-1 QC Samples Table

Matrix: Aqueous (groundwater and surface water)						
Analytical Group/Concentration Level: VOC (Trace)						
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5, 1-9 & 3-1 & PSOP-1						
Analytical Method / SOP Reference: SOM01.2						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA, EPA CLP or CDM Subcontract lab (FASTAC will be followed)						
No. of Sample Locations: 269 groundwater screening, 19 groundwater new wells, 4 municipal public supply, 7 surface water and 5 groundwater seepage samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	CRQL
Trip blank	1 per cooler containing VOC	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	1 per 12 hours per instrument	≤ CRQL	Per SOM01.2	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
DMC	Each Sample and Standard	28-155	Per SOM01.2	Laboratory analyst	Accuracy	As per method
LCS	1 per SDG per matrix	Per SOM01.2	Per SOM01.2	Laboratory analyst	Accuracy/bias	75-125% recovery

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below contract required quantitation limit (CRQL) or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute value RPD = relative percent difference

For Worksheet #28 DESA requirements are included in Appendix G.



**QAPP Worksheet #28-2
QC Samples Table**

Matrix: Aqueous (groundwater and surface water)
Analytical Group/Concentration Level: TCL SVOC/ Low
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5 & 1-9
Analytical Method / SOP Reference: SOM01.2
Sampler's Name/ Field Sampling Organization: TBD/CDM
Analytical Organization: DESA, EPA CLP or CDM Subcontract lab (FASTAC will be followed)
No. of Sample Locations: 19 groundwater new wells, 4 municipal public supply , 7 surface water and 5 groundwater seepage samples

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler containing VOCs	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	each extract batch	≤ CRQL	Identify problem; re-extract; reanalyze	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	22-150, 1-145 for 4-chloroaniline	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Surrogates (DMC)	Per SOM01.2	Per SOM01.2	Per SOM01.2	Laboratory analyst	Accuracy	As per method

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = laboratory control sample

MPC = measurement performance criteria

ABS = absolute difference

RPD = relative percent difference

DMC = deuterated monitoring compound

QAPP Worksheet #28-3
QC Samples Table

Matrix: Aqueous (groundwater and surface water)						
Analytical Group/Concentration Level: TCL Pesticides/ Low						
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5 & 1-9						
Analytical Method / SOP Reference: SOM01.2						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA, EPA CLP or CDM Subcontract lab (FASTAC will be followed)						
No. of Sample Locations: 19 groundwater new wells, 4 municipal public supply , 7 surface water and 5 groundwater seepage samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	each extract batch	≤ CRQL	Identify problem; re-extract; reanalyze	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples	None	Data assessor to inform SM if RPD OR ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Surrogates	For each sample and standard	30-150	Per SOM01.2	Laboratory analyst	Accuracy	As per method
MS/MSD	1 per 20 samples	0-27 RPD 38- 131% recovery	Per SOM01.2	Laboratory analyst	Accuracy and Precision	As per method and DV SOP

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

**QAPP Worksheet #28-4
QC Samples Table**

Matrix: Aqueous (groundwater and surface water)
Analytical Group/Concentration Level: TCL PCBs/ Low
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5, & 1-9
Analytical Method / SOP Reference: SOM01.2
Sampler's Name/ Field Sampling Organization: TBD/CDM
Analytical Organization: DESA, EPA CLP or CDM Subcontract lab (FASTAC will be followed)
No. of Sample Locations: 19 groundwater new wells, 4 municipal public supply , 7 surface water and 5 groundwater seepage samples

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	each extract batch	≤ CRQL	Identify problem; re-extract; reanalyze	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Surrogates	Per SOM01.2	Per SOM01.2	Per SOM01.2	Laboratory analyst	Accuracy	As per method
MS/MSD	1 per 20 samples Per matrix	Per SOM01.2	Per SOM01.2	Laboratory analyst	Accuracy and Precision	As per method and DV SOP

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

**QAPP Worksheet #28-5
QC Samples Table**

Matrix: Aqueous (groundwater and surface water)						
Analytical Group/Concentration Level: TAL Metals, Mercury, Cyanide /Low						
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5 & 1-9						
Analytical Method / SOP Reference: CLP ILM05.4						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA, EPA CLP or CDM Subcontract lab (FASTAC will be followed)						
No. of Sample Locations: 19 groundwater new wells, 4 municipal public supply , 7 surface water and 5 groundwater seepage samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per ILM05.4	≤ CRQL	Per ILM05.4	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples	None	Data assessor inform SM if RPD or ABS exceeds MPC*	Laboratory analyst/FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5x CRQL
Matrix Spike	1 per 20 samples	75-125%	Per ILM05.4	Laboratory analyst/FTL	Accuracy	Recovery 75-125%
Laboratory Duplicate	1 per 20 samples	RPD < 20%	Per ILM05.4	Laboratory analyst/FTL	Precision	RPD ≤ 20%
LCS	1 per 20 samples	80-120% mercury 85-115%	Per ILM05.4	Laboratory analyst/FTL	Accuracy and Precision	80-120% recovery

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-6
QC Samples Table

Matrix: Aqueous (groundwater and surface water)						
Analytical Group/Concentration Level: Non-RAS (Method 300 series)/ Low						
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5 & 1-9						
Analytical Method / SOP Reference: See worksheets 19 & 23						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CDM Subcontract lab (FASTAC will be followed)						
No. of Sample Locations: 19 groundwater new wells, 4 municipal public supply , 7 surface water and 5 groundwater seepage samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Preparation blank	Per ILM05.4	≤ CRQL	Per ILM05.4	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate ¹	1 per 20 samples per matrix	None	Data assessor inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Matrix Spike	1 per 20 samples	75-125%	Per ILM05.4	Laboratory analyst	Accuracy	Recovery 75-125%
Laboratory Duplicate	1 per 20 samples	RPD < 20%	Per ILM05.4	Laboratory analyst	Precision	RPD ≤ 40%
LCS	1 per 20 samples	80-120%;	Per ILM05.4	Laboratory analyst	Accuracy and Precision	80-120% recovery

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report.

1. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-7
QC Samples Table

Matrix: Aqueous (groundwater and surface water)						
Analytical Group/Concentration Level: Gases (Methane, Ethane, Ethane) / Low						
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1,1-5 & 1-9						
Analytical Method / SOP Reference: RSK 175						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CDM Subcontract lab (FASTAC will be followed)						
No. of Sample Locations: 19 groundwater new wells, and 4 municipal public supply						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Trip blank	1 per cooler	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per SOM01.2	≤ CRQL	Per SOM01.2	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Standard Checks	1 per SDG per matrix	Per SOM01.2	Per SOM01.2	Laboratory analyst/FTL	Precision Accuracy/bias	75-125% recovery

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-8
QC Samples Table

Matrix: Aqueous (groundwater and surface water)
Analytical Group/Concentration Level: TOC/ Low
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5 & 1-9
Analytical Method / SOP Reference: EPA 415.1 or 415.2
Sampler's Name/ Field Sampling Organization: TBD/CDM
Analytical Organization: DESA or CDM Subcontract lab (FASTAC will be followed)
No. of Sample Locations: 19 groundwater new wells, 4 municipal public supply , 7 surface water and 5 groundwater seepage samples

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Calibration blank	1 per sample run	≤ CRQL	Verify results; reanalyze; recalibrate if still outlying	Laboratory analyst	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Field Duplicate*	1 per 20 samples	None	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Carbonate-bicarbonate standard	1 per batch	± 10% of true value	Re-prep and re-analyze; recalibrate if still outlying	Laboratory analyst	Contamination – Accuracy/bias	± 20% of true value
Matrix spike	1 per batch	75-125%			Accuracy/bias	75-125% recovery
LCS	1 per batch	± 20% of true value			Accuracy/bias	± 20% of true value

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

**QAPP Worksheet #28-9
QC Samples Table**

Matrix: Aqueous (groundwater and surface water)
Analytical Group/Concentration Level: TDS, TSS, Hardness/ Low
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), TSOP 1-1, 1-5 & 1-9
Analytical Method / SOP Reference: EPA 160.1, 160.2, & hardness by 130.1/130.2/200.7 or ILM05.4
Sampler's Name/ Field Sampling Organization: TBD/CDM
Analytical Organization: DESA or CDM Subcontract lab (FASTAC will be followed)
No. of Sample Locations: 19 groundwater new wells, 4 municipal public supply , 7 surface water and 5 groundwater seepage samples

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Calibration blank	1 per sample run	≤ CRQL	Verify results; reanalyze; recalibrate if still outlying	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Detection Limit Verification Standard	1 per sample run	± 20% of true value		Laboratory analyst	Accuracy/bias	± 20% of true value

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-10
QC Samples Table

Matrix: Aqueous (groundwater)						
Analytical Group/Concentration Level: Ferrous Iron / Low						
Sampling SOP: Maunabo Low-flow Groundwater SOP (App. A), & TSOP 1-9						
Analytical Method / SOP Reference: HACH 8146						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: CDM on-site						
No. of Sample Locations: 19 groundwater new wells, and 4 municipal public supply						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Replicate	1 per 20 samples	NA	Re-check; then re-prep and re-analyze; recalibrate if standard check is outlying	Field analyst & FTL	Precision	± 50% RPD
Field Duplicate*	1 per 20 samples per matrix	NA		Field analyst & FTL	Precision	± 50% RPD
Standard Check	With each use of instrument	NA		Field analyst & FTL	Accuracy/bias	75-125% recovery
Blank Check	1 per 20 samples	NA		Field analyst & FTL	Contamination - Accuracy/bias	≤ CRQL

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute value RPD = relative percent difference

QAPP Worksheet #28-11
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: TCL VOCs/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: CLP SOM01.2						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per SOM01.2	≤ CRQL	Per SOM01.2	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Surrogates	Per SOM01.2	Per SOM01.2	Per SOM01.2	Laboratory analyst	Accuracy	As per method

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-12
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: TCL SVOCs/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: CLP SOM01.2						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per extract batch	≤ CRQL	Identify problem; re-extract & reanalyse	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5 X CRQL
Surrogates (DMC)	Per SOM01.2	1-145 for 4 chloroaniline	Per SOM01.2	Laboratory analyst	Accuracy	As per method

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-13
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: TCL Pesticides/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: CLP SOM01.2						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ Criteria on Worksheet 15
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per SOM01.2	≤ CRQL	Per SOM01.2	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD OR ABS exceeds MPC	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Surrogates	Per SOM01.2	Per SOM01.2	Per SOM01.2	Laboratory analyst	Accuracy	As per method and DV SOP
MS/MSD	1 per 20 samples	Per SOM01.2	Per SOM01.2	Laboratory analyst/FTL	Accuracy and Precision	

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-14
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: TCL PCBs/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: CLP SOM01.2						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per SOM01.2	≤ CRQL	Per SOM01.2	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor to inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Surrogates	Per SOM01.2	Per SOM01.2	Per SOM01.2	Laboratory analyst	Accuracy	As per method
MS/MSD	1 per 20 samples	Per SOM01.2	Per SOM01.2	Laboratory analyst/FTL	Accuracy and Precision	As per method and DV SOP

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-15
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: TAL Metals, Mercury, Cyanide/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: CLP ILM05.4						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ CRQL
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for data validation	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Method blank	Per ILM05.4	≤ CRQL	Per ILM05.4	Laboratory analyst	Contamination – Accuracy/bias	≤ CRQL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Matrix Spike	1 per 20 samples per matrix	75-125% 80-120% for mercury	Per ILM05.4	Laboratory analyst	Accuracy	Recovery 75-125%
Laboratory Duplicate	1 per 20 samples	RPD < 20%	Per ILM05.4	Laboratory analyst/FTL	Precision	RPD ≤ 20%
LCS	1 per 20 samples	80-120%; mercury 85-115%	Per ILM05.4	Laboratory analyst/FTL	Accuracy and Precision	80-120% recovery

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected five times below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-16
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: pH/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: SW-846						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for DV	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 100% ABS ≤ 5X CQL
Laboratory duplicate	1 per 20 samples	As per methods	As per methods	Laboratory analyst	Precision	RPD ≤ 40%
Standard check (pH)	With each use of instrument	± 0.5 of true value	Re-prepare and re-analyze; re-calibrate if still outlying	Laboratory analyst	Accuracy/bias	± 0.5 of true value

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-17
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: TOC/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: Lloyd Kahn with additional QC requirements						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field rinsate blank	1 per decontamination event per matrix; or 1 per day	≤ CRQL	Verify results; reanalyze	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ QL
Preparation blank	1 per batch	≤ 100 mg/kg	Verify results; reanalyze; recalibrate if still outlying	Laboratory analyst/FTL	Contamination – Accuracy/bias	≤ QL
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X CRQL
Quadruplicate analysis	Per batch	± 25% of true value	Identify error and re-analyze	Laboratory analyst	Precision	± 40% of true value
Detection Limit Verification Standard	1 per sample run	± 25% of true value		Laboratory analyst	Accuracy/bias	± 20% of true value
Duplicate analysis	Every sample	RPD ≤ 20%	Re-run sample; flag and note in report	Laboratory analyst	Precision	RPD ≤ 100%

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report.. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #28-18
QC Samples Table

Matrix: Soil/sediment						
Analytical Group/Concentration Level: Grain Size/ Low						
Sampling SOP: TSOPs 1-3 (surface soil), 1-4 (subsurface soil), & 1-11 (sediment)						
Analytical Method / SOP Reference: CLP SOM01.2						
Sampler's Name/ Field Sampling Organization: TBD/CDM						
Analytical Organization: DESA or CLP (FASTAC will be followed)						
No. of Sample Locations: 24 soil and 7 sediment samples						
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Temperature blank	1 per cooler	≤ 6 degrees C; ≤ 10 degrees C for DV	Inform field crew to use adequate coolant	Laboratory analyst/FTL	Accuracy/bias	≤ 10 degrees Celsius
Field Duplicate*	1 per 20 samples per matrix	None	Data assessor inform SM if RPD or ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 100%
Laboratory duplicate	1 per 20 samples	As per methods	As per methods	Laboratory analyst	Precision	RPD ≤ 40%

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CQL or up to 5 times the CQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report.. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

Matrix: Air
Analytical Group/Concentration Level: VOC
Sampling SOP: TSOP 1-8
Analytical Method / SOP Reference: TO-15
Sampler's Name/ Field Sampling Organization: TBD/CDM
Analytical Organization: DESA, EPA CLP or CDM Subcontract lab (FASTAC will be followed)
No. of Sample Locations: 4 initial sub-slab and 4 concurrent sub-slab and air samples plus 1 ambient air.

**QAPP Worksheet #28-19
QC Samples Table**

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Duplicate ¹	1 per 20 samples	None	Data assessor to inform SM if RPD OR ABS exceeds MPC*	FTL	Homogeneity/Precision	RPD ≤ 50% ABS ≤ 5X QL
Instrument Blank	1 per 20 samples	≤ QL	Check for problem and fix prior to sampling	Laboratory Analyst	Accuracy	≤ QL
LCS	1 per 20 samples	70-130% Recovery	Check for problem and fix prior to sampling	Laboratory Analyst	Accuracy	70-130% recovery
Method Blank	1 per 20 samples	≤ QL	Check for problem and fix prior to sampling	Laboratory Analyst	Accuracy	≤ QL

The number of QC samples are listed on Worksheet 20

ABS applied when sample or duplicate results are detected below CRQL or up to 5 times the CRQL.

* This will be documented on Field Duplicate Comparison Table in the data quality report.. See worksheet 37 for Usability Assessment

LCS = Laboratory control sample MPC = measurement performance criteria ABS = absolute difference RPD = relative percent difference

QAPP Worksheet #29
Project Documents and Records Table

Sample Collection Documents and Records	On-Site Analysis Documents and Records	Off-Site Analysis Documents and Records	Data Assessment Documents and Records	Other
Forms II Lite Traffic Reports/ COC Records	Equipment Calibration and Maintenance Log	Sample Receipt, Custody and Tracking Logs	Field Sampling Audit Plans, Reports and Checklists	M&TE (measurement and testing equipment) Forms
Airbills	Field Data Collection Logs	Standards Tracking Logs	Office Audit Plans, Reports and Checklist	Technical/QA Review Forms
Sample Tracking Log/Sheets	Drilling Logs	Equipment Maintenance, Testing and Inspection Log	Corrective Action Reports	Purchase Requisition Forms
Field Logbooks	PID Logs	Sample Preparation Logs	Analytical sample results	Telephone Logs
Chain of Custody Forms	Water Quality Data Logs	Corrective Action Reports	Subcontract Laboratory certifications	Electronic Data Deliverables
Field Change Request Forms	Monitoring Well Logs	Run Logs	Subcontract Laboratory QA Plan (on file with EPA and CDM)	Subcontract Documents (Contract, Scopes of Work, Bid Sheet), Subcontract Documents and Review Forms
Custody Seals	Photographs	Corrective Action Forms	Laboratory Audit Report (optional)	NA
Daily/weekly reports	Meteorological Data from field (documented in Field Logbooks)	Data Packages (Case Narratives, Sample Results, QC Summaries and Raw Data (detailed in CLP SOPs).	Data Package Completeness Checklist Validated Data Reports	NA
ANSETS Forms	NA	Trip Reports	Self Assessment Checklist	NA
Survey Records	NA	Sample Disposal and Waste Manifests	Data Quality Assessments	NA
NA	NA	NA	NA	Technical Memos
NA	NA	NA	NA	Draft and Final RI Reports

Identify the documents and records that will be generated for all aspects of the project including, but not limited to, sample collection and field measurement, on-site and off-site analysis, and data assessment.

For Worksheet #29 DESA requirements are included in Appendix G.

QAPP Worksheet #30
Project Analytical Services Table

Matrix	Analytical Group	Concentra- tion Level	Sample Locations/ ID Number	Analytical SOP ¹	Data Package Turnaround Time	Laboratory / Organization (name, address, contact person & telephone number)	Backup Laboratory / Organization ² (name, address, contact person & telephone number)
Groundwater Screening Sampling							
Aqueous	VOCs	Trace	see Figure 5/ worksheet # 26	SOM01.2	24 hours data (42 days for full package)	subcontact lab TBD	
Municipal Public Supply and Monitoring Well Sampling							
Aqueous	VOCs	Trace	see Figure 6/ worksheet # 26	SOM01.2	42 days (21 days for data receipt and 21 days for data validation)	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171 DESA contact: John Birri 732-906-6886	EPA CLP – TBD via RSCC
Aqueous	TCL SVOCs, Pesticides, and PCBs	Low		SOM01.2		DESA/RSCC Contacts as above	Subcontract laboratory - TBD
Aqueous	TAL Metals, mercury and cyanide	Low		ILM05.4/ ILM05.4			
Aqueous	Wet chemistry parameters (see worksheets 19 & 20)	Low		Various (Worksheet 19)			
Aqueous	methane, ethane, ethane	Low		RSK 175			
Aqueous	ferrous iron	Low		HACH 8146	On-site analysis		
Surface Water Sampling							
Aqueous	VOCs	Trace	see Figure 7/ worksheet # 26	SOM01.2	42 days (21 days for data receipt and 21 days for data validation)	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171	EPA CLP – TBD via RSCC
Aqueous	TCL SVOCs, Pesticides, and PCBs	Low				ILM05.3/ ILM05.4	
Aqueous	Metals, mercury and cyanide	Low					



QAPP Worksheet #30
Project Analytical Services Table

Matrix	Analytical Group	Concentra- tion Level	Sample Locations/ ID Number	Analytical SOP ¹	Data Package Turnaround Time	Laboratory / Organization (name, address, contact person & telephone number)	Backup Laboratory / Organization ² (name, address, contact person & telephone number)
Aqueous	Wet chemistry parameters (see worksheets 19 and 20 for list)	Low		Various (Worksheet 19)		DESA contact: John Birri 732-906-6886	Subcontract laboratory TBD
Groundwater Seepage Samples							
Aqueous	VOCs	Trace	see Figure 7/ worksheet # 26	SOM01.1	42 days	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171	EPA CLP – TBD via RSCC
Aqueous	TCL SVOCs, Pesticides, and PCBs	Low		SOM01.1			
Aqueous	Metals, mercury and cyanide	Low		ILM05.3/ ILM05.4			
Aqueous	Wet chemistry parameters (see worksheets 19 and 20 for list)	Low		Various (Worksheet 19)		DESA contact: John Birri 732-906-6886	Subcontract laboratory TBD
Source Area Soil Investigation							
Soil	TCL VOCs, SVOCs, Pesticides, and PCBs	Low	locations to TBD/ worksheet # 26	SOM01.2	42 days (21 days for data receipt and 21 days for data validation)	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171	EPA CLP – TBD via RSCC
Soil	Metals, mercury and cyanide	Low		ILM05.4/ ILM05.4			
Soil	pH	Low		9045C			
Soil	TOC	Low		Lloyd Kahn		DESA contact: John Birri 732-906-6886	Subcontract laboratory TBD
Soil	Grain size	Low		D421-85 & D422-63			
Sediment Sampling							
Soil	TCL VOCs, SVOCs, Pesticides, and PCBs	Low	see Figure 7/ worksheet # 26	SOM01.2	42 days (21 days for data receipt and 21 days for data validation)	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171	EPA CLP – TBD via RSCC
Soil	Metals, mercury and cyanide	Low		ILM05.4/ ILM05.4			
Soil	pH	Low		9045C			Subcontract laboratory - TBD



QAPP Worksheet #30
Project Analytical Services Table

Matrix	Analytical Group	Concentra- tion Level	Sample Locations/ ID Number	Analytical SOP ¹	Data Package Turnaround Time	Laboratory / Organization (name, address, contact person & telephone number)	Backup Laboratory / Organization ² (name, address, contact person & telephone number)
Soil	TOC	Low		Lloyd Kahn		DESA contact: John Birri 732-906-6886	
Soil	Grain size	Low		D421-85 & D422-63			
Diffusion Bags Sampling							
Aqueous	TCL VOCs	Low	see Figure 7/ worksheet # 26	SOM01.2	42 days (21 days for data receipt and 21 days for data validation)	DESA EPA Primary contact: RSCC Adly Michael/Bob Toth 732-906-6161/6171 DESA contact: John Birri 732-906-6886	EPA CLP – TBD via RSCC
Air Sampling							
Air	VOCs	Low	locations to TBD/ worksheet # 26	TO-15	42 days (21 days for data receipt and 21 days for data validation)	EPA Air Contract Laboratory TBD	EPA Air Contract laboratory TBD

1. Please note that the required quantitation limits and CLP method options are detailed on worksheet 15
2. One of CDM's BOA subcontractor laboratories will be used if DESA or CLP cannot be used

**QAPP Worksheet #31
Planned Project Assessments Table**

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person Responsible for Identifying and Implementing Corrective Actions (CA)	Person(s) Responsible for Monitoring Effectiveness of CA
Sample collection and documentation	Once	Internal	CDM	Approved field auditor	Jose Reyes, Mike Valentino	Brendan MacDonald (RITM), Jose Reyes (FTL)	Field auditor or Jeniffer Oxford
Health and Safety	Once if warranted	Internal	CDM	Shawn Oliveira, HSM or designee	Brendan MacDonald, Mike Valentino	Brendan MacDonald, Mike Valentino	Shawn Oliveira
Field Sampling Technical Systems Audit	Once	Internal	CDM	Approved field auditor	Brendan MacDonald, Mike Valentino, Jose Reyes	Jose Reyes and field staff, Brendan MacDonald	Doug Updike or Jeniffer Oxford
Office Audit	Once	Internal	CDM	Jeniffer Oxford, RQAC or approved CDM QA Staff	Mike Valentino	Doug Updike, Mike Valentino	Jeniffer Oxford
QAPP	Annually	Internal	CDM	Jeniffer Oxford, RQAC or designee	Mike Valentino	Jeniffer Oxford, Mike Valentino	Doug Updike
Data Review	Once	Internal	CDM	Scott Kirchner or designee	Mike Valentino	Mike Valentino & Laboratory manager(s) (TBD)	Scott Kirchner
Management Systems Review	Annually	Internal	CDM	Doug Updike	Jeanne Litwin	Jeanne Litwin, Mike Valentino	Doug Updike

For Worksheet #31 DESA requirements are included in Appendix G.

CDM

Final Quality Assurance Project Plan

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QAPP Worksheet #32
Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Sample collection and documentation	Memorandum	Joes Reyes (FTL), Mike Valentino (SM)	Day of audit	Verbal briefing; Corrective Action Notice if severe or critical violations noted	Doug Updike, CDM QA Manager	Immediate CA required where possible; otherwise as specified on the CA Notice, typically 15 to 30 days from date of CA Notice
Health and Safety	Audit checklist	Brendan MacDonald (RITM), Mike Valentino (SM)	Notify by phone immediately Report 1 week after audit	Memorandum	Shawn Oliveira, CDM Health and Safety Manager	
Field Sampling Technical Systems Audit days	Field Audit Report	Brendan MacDonald (RITM), Mike Valentino (SM)	Provide summary of findings to field team on day of audit; Draft Report due 15 days	Corrective Action Plan	Doug Updike	
Office Audit	Office Audit Report	Mike Valentino (SM)	Provide summary of findings to SM on day of audit; Draft Report due 15 days	Memorandum	Doug Updike	
QAPP	Memorandum	Mike Valentino (SM)	Draft Report due 15 days	Memorandum and/or FCRs	Jeniffer Oxford RQAC and Doug Updike	
Data review	Memorandum	Mike Valentino (SM)	1 week	Memorandum	Jeanne Litwin, Program Manager	
Management Systems Review	MSR report	Jeanne Litwin (RAC II PSO)	2 weeks	Memorandum	Doug Updike	

For Worksheet #32 DESA requirements are included in Appendix G.



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QAPP Worksheet #33
QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)¹	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Change Requests	As needed	Ongoing	Jose Reyes, FTL	QAPP recipients
QAPP Addendums	As needed	N/A	Brendan MacDonald, RITM	QAPP recipients
Field Audit Report	Once	30 days after completion of report	Field Auditor	Mike Valentino, SM Bob Goltz, Officer in Charge, Jeanne Litwin, Program Manager Doug Updike, QA Manager, Carlos O'Neill, EPA RPM William Sy, EPA QA
Office Audit Report	Once	30 days after completion of report	Jeniffer Oxford, RQAC or designee	
Corrective Action Request	As needed	30 days or sooner dependant on the nature of the request	Corrective Action Request	
Corrective Action Reports	As required on CA request	Determined by Auditor	QA Auditor	
Corrective Action Plan	As needed	Within 2 weeks of request	Site Manager	Fernando Rosado, EPA Carlos O'Neill, EPA RPM Other EPA and stakeholders as directed by the EPA RPM Mike Valentino, SM Jeanne Litwin, Program Manager
Data Usability Assessments	With each Measurement Report	May 2010 RA Screening Technical Memorandum (TM) -Nov 2010 RA Evaluation TM - Dec 2010	Scott Kirchner, ASC	
Technical Memorandums	At completion of field investigations	June 2010	SM	
RI Report (Draft and Final)	Once	July 2010 Oct 2010	SM	

1. These are the anticipated dates. Actual dates may change due to unexpected delays.

**QAPP Worksheet #34
Verification (Step I) Process Table**

Verification Input	Descriptions	Internal/ External	Responsible for Verification (Name, Organization)
Chain of custody	Form will be internally reviewed upon completion and verified against field logs, laboratory report and QAPP. Review will be conducted with completion of each measurement report.	Both	EPA or CDM validator Brendan MacDonald - CDM Scott Kirchner (ASC) - CDM
Field Report	Field reports will be verified with field log books to ensure correct reporting of information. Review will be conducted with completion of each report.	Internal	Brendan MacDonald (RITM) - CDM
Field Logbooks	Field logbooks will be reviewed for accuracy and completeness and placed in project file.	Internal	Brendan MacDonald (RITM) - CDM FTL - CDM
Field and Laboratory data and QC Report	Data validation reports, QAPP, FCRs and outputs of the EQuis database will be used to prepare the project data quality and usability assessment report. The data will be evaluated against project DQOs and measurement performance criteria, such as completeness.	Both	Scott Kirchner (ASC) - CDM
Sampling Procedures	Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support using audit and sampling reports, field change request forms and field logbooks.	Internal	Brendan MacDonald (RITM) - CDM
Laboratory Data	All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to submittal to EPA. Subsequently, EPA or its contractor will evaluate the data packages for completeness and compliance. Table 9 of the IDQTF UFP-QAPP shows items for compliance review.	External	Laboratory manager or QA Officer - TBD EPA or CDM validator
Electronic Data Deliverables (EDDs)	Determine whether required fields and format were provided.	Internal	Melinda Olsen - CDM
QAPPS	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	Internal	All data users

Step I = Data verification review for completeness
For Worksheet #34 DESA requirements are included in Appendix G..

QAPP Worksheet #35
Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
IIa	Methods	Records support implementation of the SOP - sampling and analysis	EPA (Environmental Services Assistance Team [ESAT] or DESA) CDM will validate any subcontract laboratory generated data. This form will be resubmitted if a subcontract laboratory is needed.
IIa	Chain of Custody	Examine traceability of data from sample collection to generation of project reported data. Provides sampling dates and time; verification of sample ID; and QC sample information.	
IIb	Data Narrative	Determine deviations from methods and contract and the impact.	
IIb	Audit Report	Reports used to validate compliance of field sampling, handling and analysis activities with the QAPP.	
IIb	Project Quantitation Limit	PQL achieved as outlined in the QAPP and that the laboratory successfully analyzed a standard at the QL.	
IIb	Field and Lab data and QC report	A summary of all QC samples and results will be verified for measurement performance criteria, completeness and 10% verified to field and laboratory data reports from vendors. A report on the meeting the established criteria shall be prepared within 30 days of receipt.	
IIb	Data Package	Used to perform data validation on 100% of all CLP data. Any subcontractor analyzed data will be validated by CDM. A report shall be prepared within 30 days of data receipt. Ensure that all analytical procedures were followed. Corrective actions will be taken and documented when applicable per specific methods. Deviations will be documented. Data will be qualified in accordance with specific methods.	

Step IIa = Correctness for sampling and testing. Compliance with procedures, methods and contacts.
Step IIb = Technical compliance sampling and testing. Meeting measurement performance criteria.
For Worksheet #35 DESA requirements are included in Appendix G.

QAPP Worksheet #36
Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Date Validator (Title, Organization)
IIa	Screening Samples	Trace VOCs	Low	SOP HW-34, rev 1	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Groundwater Municipal Public Supply Wells, Screening Samples, Monitoring wells	Trace VOCs	Low	SOP HW-34, rev 1	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Groundwater Municipal Public Supply Wells, Monitoring wells	Organics (SVOCs, Pesticides & PCBs)	Low	SOP HW-35/36/37, rev 1	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Groundwater Municipal Public Supply Wells, Monitoring wells	Inorganics (metals, mercury & cyanide)	Low	Evaluation of Metals Data for the CLP Program based on SOW ILM05.4, September 2006, SOP HW-2, rev 13	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Soil	Organics (VOC, SVOC, Pesticide & PCBs)	Low	SOP HW-33/35/36/37, rev 1	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Soil	Inorganics (metals, mercury & cyanide)	Low	Evaluation of Metals Data for the CLP Program based on SOW ILM05.4, September 2006, SOP HW-2, rev 13	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Soil	pH, TOC and Grain Size	Low	DESA SOP or CDM 029A SOP	ESAT DV Personnel, EPA Region 2 DV Personnel, or CDM ASC/ designee
IIa /IIb	Sediment	Organics (VOCs, SVOCs, Pesticide & PCBs)	Low	SOP HW-33/35/36/37, rev 1	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Sediment	Inorganics (metals, mercury & cyanide)	Low	Evaluation of Metals Data for the CLP Program based on SOW ILM05.4, September 2006, SOP HW-2, rev 13	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Sediment	pH, TOC and Grain Size	Low	DESA SOP or CDM 029A SOP	ESAT DV Personnel, EPA Region 2 DV Personnel, or CDM ASC/ designee
IIa /IIb	Surface Water	Trace VOCs	Low	SOP HW-34, rev 1	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Surface Water	Organics (SVOCs, Pesticides & PCBs)	Low	SOP HW-35/36/37, rev 1	ESAT DV Personnel, or EPA Region 2 - DESA
IIa /IIb	Surface Water	Inorganics (metals, mercury & cyanide)	Low	Evaluation of Metals Data for the CLP Program based on SOW ILM05.4, September 2006, SOP HW-2, rev 13	ESAT DV Personnel, or EPA Region 2 - DESA

QAPP Worksheet #36
Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Date Validator (Title, Organization)
IIa /IIb	Groundwater Municipal Public Supply Wells, Monitoring wells and Surface Water	Wet Chemistry	Low	DESA SOP or CDM 029A SOP	ESAT DV Personnel, EPA Region 2 DV Personnel, or CDM ASC/ designee
IIa /IIb	Groundwater Municipal Public Supply Wells, Monitoring wells	Methane, ethane, ethene	Low	DESA SOP or National Functional Guidelines	ESAT Data Validation Personnel, EPA Region 2 DV Personnel, or CDM ASC/ designee
IIa /IIb	Air	Organic VOCs	Low	Region II - Data Validation Guidelines SOP HW-18, Revision 0, modified for method TO-15	EPA

1. Wet chemistry includes: Full TCL/TAL parameters (including trace VOCs), alkalinity, ammonia, hardness, nitrate/nitrite, TKN, sulfate, sulfide, chloride, pH, TOC, TDS, and TSS

QAPP Worksheet #37 Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

The Data Usability Assessment will be performed by a team of personnel at CDM. Michael Valentino, SM, will be responsible for information in the Usability Assessment. He will also be responsible for assigning task work to the individual task members who will be supporting the Data Usability Assessment. Note that the Data Usability Assessment will be conducted on validated data. After the Data Usability Assessment has been performed, data deemed appropriate for use will then be used in the RI, HHRA, SLERA, and FS. The results of the Data Usability Assessment will be presented in the RI report. The following items will be assessed and conclusions drawn based on their results.

Precision – Results of laboratory duplicates will be assessed during data validation and data will be qualified according to the data validation procedures cited on Worksheet #36. Field duplicates will be assessed by matrix using the RPD for each pair of results reported above CRQL for organic and inorganic analyses respectively. RPD acceptance criteria, presented in Worksheet #12, will be used to assess field sampling precision. Absolute difference will be used for low results as described in worksheets 12 and 28. A discussion summarizing the results of laboratory and field precision and any limitations on the use of the data will be described.

Field duplicates - The site manager will review the extent of exceedance of the field duplicate criteria. For groundwater, the sample results will be flagged according to the data validation protocol. For soils/sediment, the exceedances will be compared with the field lithological logs and grain size results, if available. Based on this review, the site manager will determine whether the exceedance is due to inherent soil heterogeneity or the result of sample handling in the field or laboratory. The overall data quality cannot be assessed on the field duplicates since sample matrix non-homogeneity may drive the differences obtained. Field duplicates will be used in conjunction with results from other QC criteria to provide additional information to draw conclusions on the overall data quality. However, when used in conjunction with results from other QC criteria, field duplicates may provide additional information to draw conclusions on the overall data quality. This information will be included in the data assessment report. As an added measure, the field team leader will be asked to inspect the soil coning and quartering procedures and re-train staff if needed. The data assessor will review the data validation report. If the field duplicate comparison is not included, it will be performed by the assessor.

Data gaps - Any data gaps will be described in the technical memorandums to the EPA and the recommendations will be made to address the data gaps.

Accuracy/Bias Contamination – Results for all laboratory blanks will be assessed as part of the data validation. During the data validation process the validator will qualify the data following the procedures described on Worksheet #36. A discussion summarizing the results of laboratory accuracy and bias based on contamination will be presented and any limitations on the use of the data will be described.

Overall Accuracy/Bias – The results of instrument calibration and matrix spike recoveries will be reviewed and data will be qualified according to the data validation procedures cited on Worksheet #36. A discussion summarizing the results of laboratory accuracy and any limitations on the use of the data will be described.

QAPP Worksheet #37 Usability Assessment

Sensitivity – Data results will be compared to criteria provided on Worksheet #15. A discussion summarizing any conclusions about sensitivity of the analyses will be presented and any limitations on the use of the data will be described.

Representativeness – A review of adherence to field procedures and of project QA audits will be performed in order to assess the representativeness of the sampling program. Data validation narratives will also be reviewed and any conclusions about the representativeness of the data set will be discussed.

Comparability – The results of this study will be used in conjunction with existing data to produce the site reports.

Reconciliation – The DQIs presented in Worksheet #12 will be examined to determine if the MPC were met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will first be evaluated separately in terms of major impacts observed from data validation, data quality indicators and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be determined. Based on the quality determined, the usability of the data for each analysis will be determined. Based on the combined usability of the data from all analyses for an objective, it will be determined if the DQIs were met and whether project goals were achieved. As part of the reconciliation of each objective, conclusions will be drawn and any limitations on the usability of any of the data will be described.

Completeness - The Environmental Quality Information Systems (EQulS) database will be queried to summarize the number of samples in each analytical fraction that are estimated and rejected. This data will be used along with the planned samples indicated in the QAPP to calculate the completeness of the obtained data set.

Data validation reports will be reviewed to determine the quality of the data and potential impacts on data usability. Field duplicates will be evaluated against the MPCs outlined in worksheet #12. Non-compliant data will be discussed in the usability report. The following equations will be used :

1. To calculate field duplicate precision: $RPD = 100 \times 2 |X1 - X2| / (X1 + X2)$ where X1 and X2 are the reported concentrations for each duplicate or replicate
2. To calculate completeness: $\% \text{ Completeness} = V/n \times 100$ where V= number of measurements judged valid; n = total number of measurements made
And $\% \text{ Completeness} = C/x \times 100$ where C= number of samples collected; x = total number of measurements planned

2. Describe the evaluative procedures used to assess overall measurement error associated with the project:

CDM will determine if quality control data is within specifications (MPC) through the data and data assessment validation process IIb.

3. Identify the personnel responsible for performing the usability assessment: Scott Kirchner, ASC or designee

QAPP Worksheet #37 Usability Assessment

4. Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

A usability report will describe the rationale for the data used and present any data limitations. The report will include a discussion of the accuracy, precision, representativeness, completeness and comparability of the data set and deviations from planned procedures and analysis and the impact on the project objectives. Tables will be prepared, including: a summary of planned samples, collected samples and parameters analyzed; detections in field and trip blanks; comparison of field duplicates; and a comparison of planned and actual detection limits.

The following procedures will be followed for using data in preparing the Technical Memorandum and the Remedial Investigation Report:

- Defining the nature and extent of contamination - CDM will evaluate individual sample results for the Technical Memorandum and the Remedial Investigation Report. The sample results will be compared to the site specific screening criteria defined as project action limits on worksheet # 5.
- Identifying data gaps - Data gaps will be identified at the end of the field investigation, while developing the data evaluation technical memorandum and while writing the RI Report. As soon as data gaps are identified, CDM will discuss them with EPA. To identify data gaps, CDM will evaluate the analytical results by media and determine if results indicate levels or locations of contamination that need to be further delineated.
- Using qualified data - CDM utilizes all data not rejected during validation to determine the nature and extent of contamination.
- Deciding if high results are legitimate or outliers - CDM will assume that all data not rejected during validation will be considered in defining the nature and extent of contamination at the site. CDM will work with EPA if there is a concern about the statistical validity of the sample results. In particular, high "outlier" results that have no surrounding comparable results as confirmation will be discussed with EPA.

Tables

Table 1
EPA December 2005 Sampling Summary
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

Facility Name	Facility Description	Former Site Uses	No. of Surface Soil Samples	No. of Subsurface Soil Samples	No. of Groundwater Samples	Results
Centro de Acopio Manufacturing	Storage of agricultural equipment.	Prefabricated piping in frame walls, plantain products, and storage of lubricant oil.	4	2	1	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.
Juan Orozco Limited, Inc.	Manufacture of guitars, guitar cases, and guitar strings.	Former site use not available.	4	3 (includes 1 dup)	1	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.
Puerto Rico Beverage	Distribution of fruit-based beverages.	Bedroom furniture and plastic filter manufacturing, emergency shelter (after a hurricane) and parking for the municipality. Hazardous substances used includes: sodium hydroxide, nitric acid, potassium hydroxide, and ethylene glycol.	4	2	1	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.

Table 1
EPA December 2005 Sampling Summary
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

Facility Name	Facility Description	Former Site Uses	No. of Surface Soil Samples	No. of Subsurface Soil Samples	No. of Groundwater Samples	Results
Plastic Home Products	Manufacture of domestic plastic products.	Furniture manufacturing, storage of emergency supplies for hurricane response.	4	2	GW not encountered.	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.
Storage Facility	Operated by Federal Emergency Management Agency (FEMA) for storage of emergency supplies intended primarily for hurricane response.	Operated by CGE for the manufacture of high voltage contactors and resistors.	5 (includes 1 dup)	2	GW not encountered.	"Non-detect" values for the chlorinated solvents detected in the Maunabo system. Future investigation recommended due to hazardous waste generated at the site during Caribe General Electric (CGE) operations.
Gas Station (GS) 1 (Esso)	Gas Station.	Former site use not available.	0	0	3 (includes 1 dup)	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.

Table 1
EPA December 2005 Sampling Summary
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

Facility Name	Facility Description	Former Site Uses	No. of Surface Soil Samples	No. of Subsurface Soil Samples	No. of Groundwater Samples	Results
Gas Station 2 (Total)	Facility abandoned and vacant.	Gas Station.	0	0	2	"Non-detect" values for the chlorinated solvents detected in the Maunabo system. Methyltertbutylether (MTBE) was detected at 14 and 7J* micrograms/liter (ug/L) in the groundwater samples collected at Gas Station (GS) 1. Benzene was also detected at GS 1 at 4J and 20 ug/L, which is above the maximum contaminant level (MCL) of 5 ug/L.
Waste Water Treatment Plant (WWTP)	Puerto Rico Aqueduct and Sewer Authority (PRASA) WWTP.	Former site use not available.	4	2	1	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.
Maunabo Landfill	Facility currently accepts "sludge".	Landfill.	4 (includes 1 dup)	1	1	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.
El Negro Auto Part	Auto parts distributor and auto repair facility.	Former site use not available.	1	0	0	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.

Table 1
EPA December 2005 Sampling Summary
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

Facility Name	Facility Description	Former Site Uses	No. of Surface Soil Samples	No. of Subsurface Soil Samples	No. of Groundwater Samples	Results
Background	NA (Not applicable)	NA	4	2	1	"Non-detect" values for the chlorinated solvents detected in the Maunabo system.

* Note: The J qualifier denotes that the identification of the analyte is acceptable and the reported value is an estimate.

Table 2
Summary of Sampling and Analysis Program
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

Sample Locations	Sample Matrix	Field Parameters	CLP Analytical Parameters	DESA or Subcontract Lab Analytical Parameters	Number of Samples (1)	Sample Frequency/Intervals
Groundwater Screening Samples (Geoprobe™)						
Transect 1	GW	DO, Eh, Turb, pH, Cond, Temp	NA	VOCs (<1 ug/L) (24-hour turnaround)	130	Sample every 10 feet
Transect 2	GW	DO, Eh, Turb, pH, Cond, Temp	NA	VOCs (<1 ug/L) (24-hour turnaround)	65	Sample every 10 feet
Transect 3	GW	DO, Eh, Turb, pH, Cond, Temp	NA	VOCs (<1 ug/L) (24-hour turnaround)	35	Samples every 10 feet
Transect 4	GW	DO, Eh, Turb, pH, Cond, Temp	NA	VOCs (<1 ug/L) (24-hour turnaround)	52	Samples every 10 feet
Contingent	GW	DO, Eh, Turb, pH, Cond, Temp	NA	VOCs (<1 ug/L) (24-hour turnaround)	52	Samples every 10 feet
Soil Samples (Geoprobe™)						
Surface Soil	Soil	NA	Full TCL/TAL	TOC, pH, Grain Size (50% of samples)	6	1 sample per location (0 to 1 foot bgs)
Soil Borings	Soil	NA	Full TCL/TAL	TOC, pH, Grain Size (50% of samples)	18	6 boreholes 3 samples per borehole
Monitoring Well Samples (Shallow and Deep Wells) - Round 1 and Round 2						
Groundwater Sampling - Rounds 1 and 2	GW	DO, Eh, Turb, pH, Cond, Temp, ferrous iron	Trace VOCs, TCL SVOCs and P/PCBs, TAL metals, cyanide	Chloride, methane, ethane, ethene, nitrate, nitrite, sulfate, sulfide, TOC, TDS, TSS, alkalinity, ammonia, hardness, and TKN	32	16 wells installed 2 sampling rounds

Table 2
Summary of Sampling and Analysis Program
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

Sample Locations	Sample Matrix	Field Parameters	CLP Analytical Parameters	DESA or Subcontract Lab Analytical Parameters	Number of Samples (1)	Sample Frequency/Intervals
Monitoring Well Samples - Bedrock Monitoring Wells - FEMA - Round 1 and Round 2						
Groundwater Sampling - Rounds 1 and 2	GW	DO, Eh, Turb, pH, Cond, Temp, ferrous iron	Trace VOCs, TCL SVOCs and P/PCBs, TAL metals, cyanide	chloride, methane, ethane, ethene, nitrate, nitrite, sulfate, sulfide, TOC, TDS, TSS, alkalinity, ammonia, hardness, and TKN	6	3 wells installed 2 sampling rounds
Monitoring Well Samples - Maunabo Public Supply Wells - Round 1 and Round 2						
Groundwater Sampling - Rounds 1 and 2	GW	DO, Eh, Turb, pH, Cond, Temp, ferrous iron	Trace VOCs, TCL SVOCs and P/PCBs, TAL metals, cyanide	chloride, methane, ethane, ethene, nitrate, nitrite, sulfate, sulfide, TOC, TDS, TSS, alkalinity, ammonia, hardness, and TKN	8	4 supply wells 2 sampling rounds
Surface Water and Sediment Samples						
Surface Water	SW	DO, Eh, Turb, pH, Cond	Trace VOCs, TCL SVOCs and P/PCBs, TAL metals, cyanide	chloride, nitrate, nitrite, sulfate, sulfide, TOC, TDS, TSS, alkalinity, ammonia, hardness, and TKN	7	1 sample per location
Sediment	SD	NA	Full TCL/TAL	pH, TOC, grain size	7	1 sample per location
Vapor Intrusion Samples						
Air Sampling	Air	NA	Selected VOCs based on groundwater screening and monitoring well data	NA	13	4 resident/building locations 1 initial sub-slab sample per location 1 concurrent sub-slab and 1 indoor air sample per location 1 background ambient air

Table 2
Summary of Sampling and Analysis Program
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

Sample Locations	Sample Matrix	Field Parameters	CLP Analytical Parameters	DESA or Subcontract Lab Analytical Parameters	Number of Samples (1)	Sample Frequency/Intervals
Streambed Groundwater Seepage Samples						
Groundwater Seepage /Diffusion Bag Samples	GW	DO, Eh, Turb, pH, Cond	TCL SVOCs and P/PCBs, TAL metals, cyanide	Trace VOCs - Diffusion Bags, chloride, nitrate, nitrite, sulfate, sulfide, TOC, TDS, TSS, alkalinity, ammonia, hardness, and TKN	10	1 sample each for the 5 temporary piezometers 5 seepage bailed samples 5 diffusion bag samples

Notes:

(1) environmental samples only

Abbreviations:

bgs = below ground surface

CLP= Contract Laboratory Program

Cond = conductivity

DESA= Division of Environmental Science and Assessment

DO = dissolved oxygen

Eh = oxidation-reduction potential

GW = groundwater

Turb. = Turbidity

NA = not applicable

P/PCB = pesticides/polychlorinated biphenyl

SD = sediment

SVOC = semivolatile organic compound

SW = surface water

TAL = Target Analyte List

TCL = Target Compound List

TDS = total dissolved solids

Temp = temperature

TKN = total Kjeldahl nitrogen

TOC = total organic carbon

TSS = total suspended solids

Turb = turbidity

VOC = volatile organic compound

µg/L = micrograms per liter

< = less than

Figures



Public Supply Wells



CDM

0 2,000 4,000 Feet

Figure 1
Site Location Map
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

R2-0000379

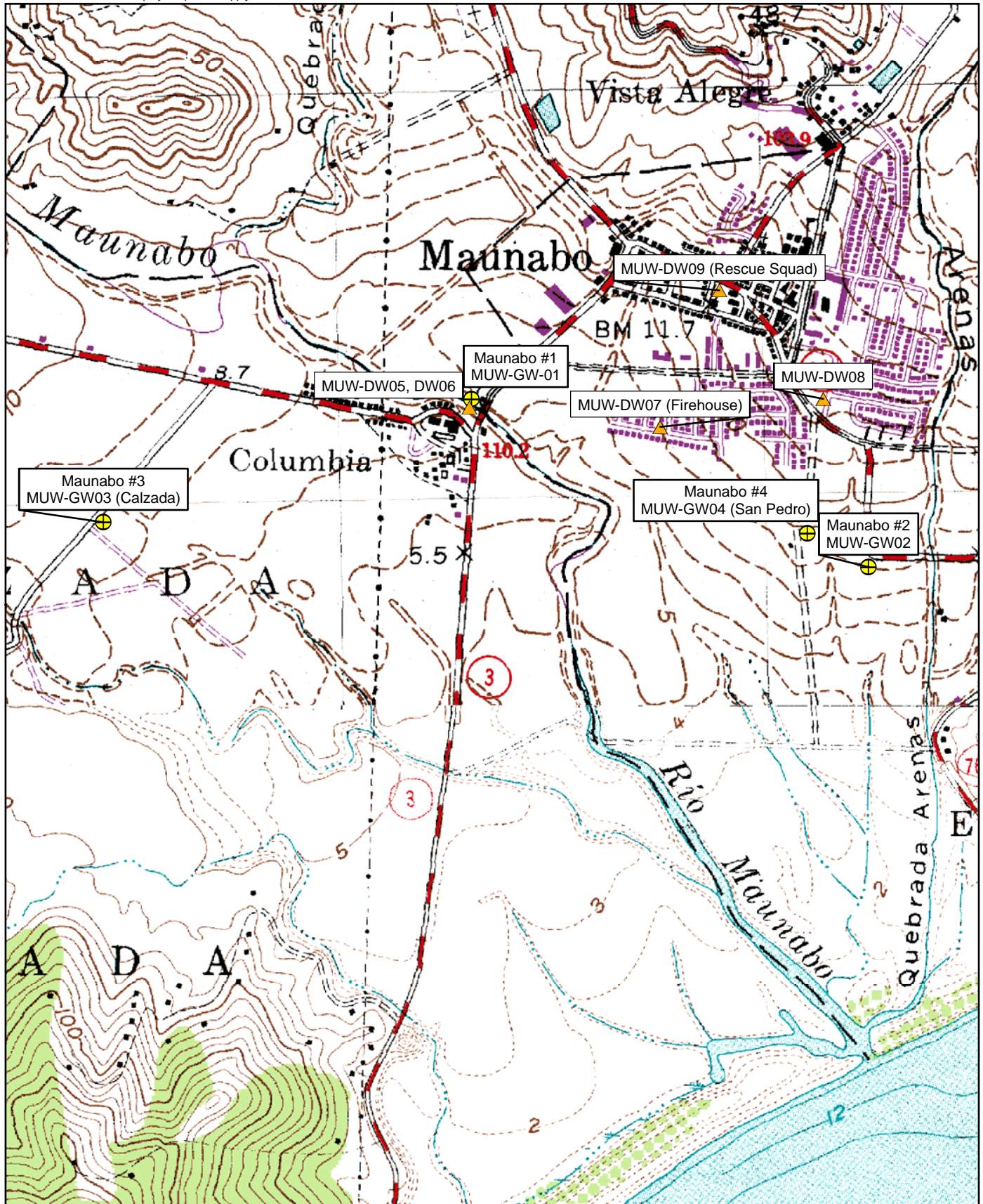
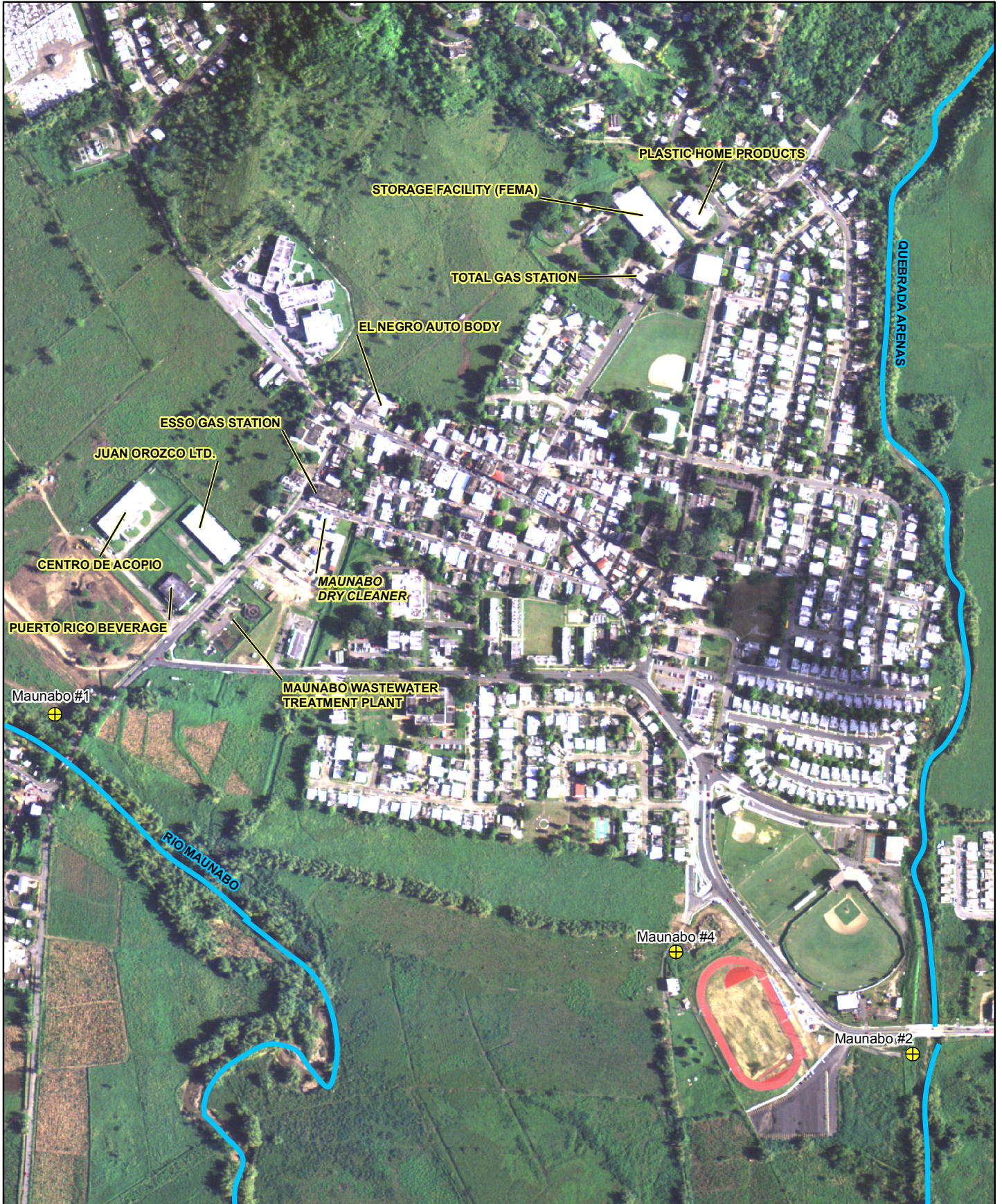


Figure 2
PRASA Supply Well and Distribution Sampling Locations
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico



Gas Station Location of Potential Source
(Italics - Not Investigated by EPA SAT2)

CDM

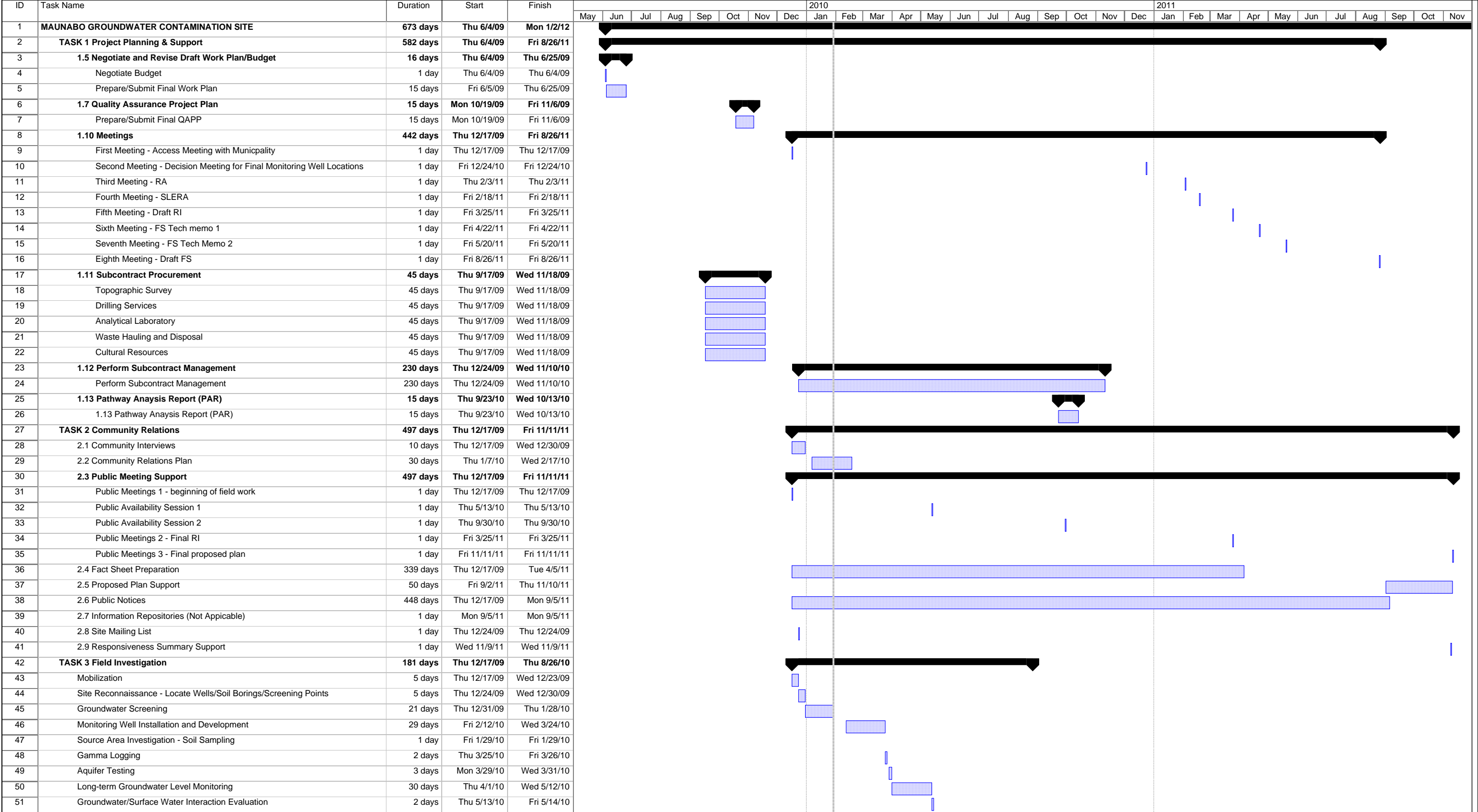


0 250 500 1,000 Feet

Figure 3
Site Map
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico

R2-0000381

Figure 4
Maunabo Groundwater Contamination Site
Project Schedule



Project: 014 Schedule 10_20_09
Date: Fri 1/29/10

Task

Progress

Milestone

Summary

Rolled Up Task

Rolled Up Milestone

Rolled Up Progress

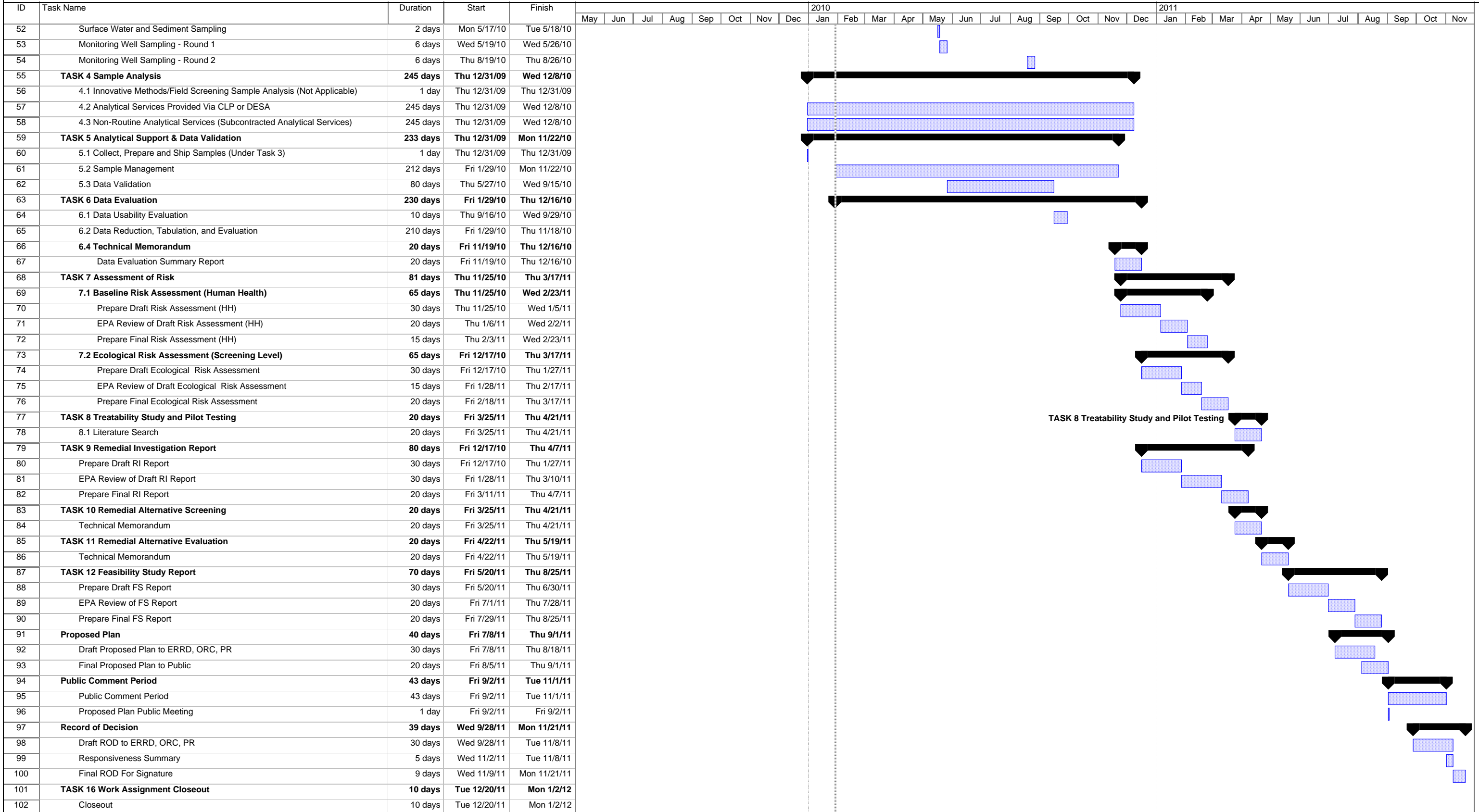
Split

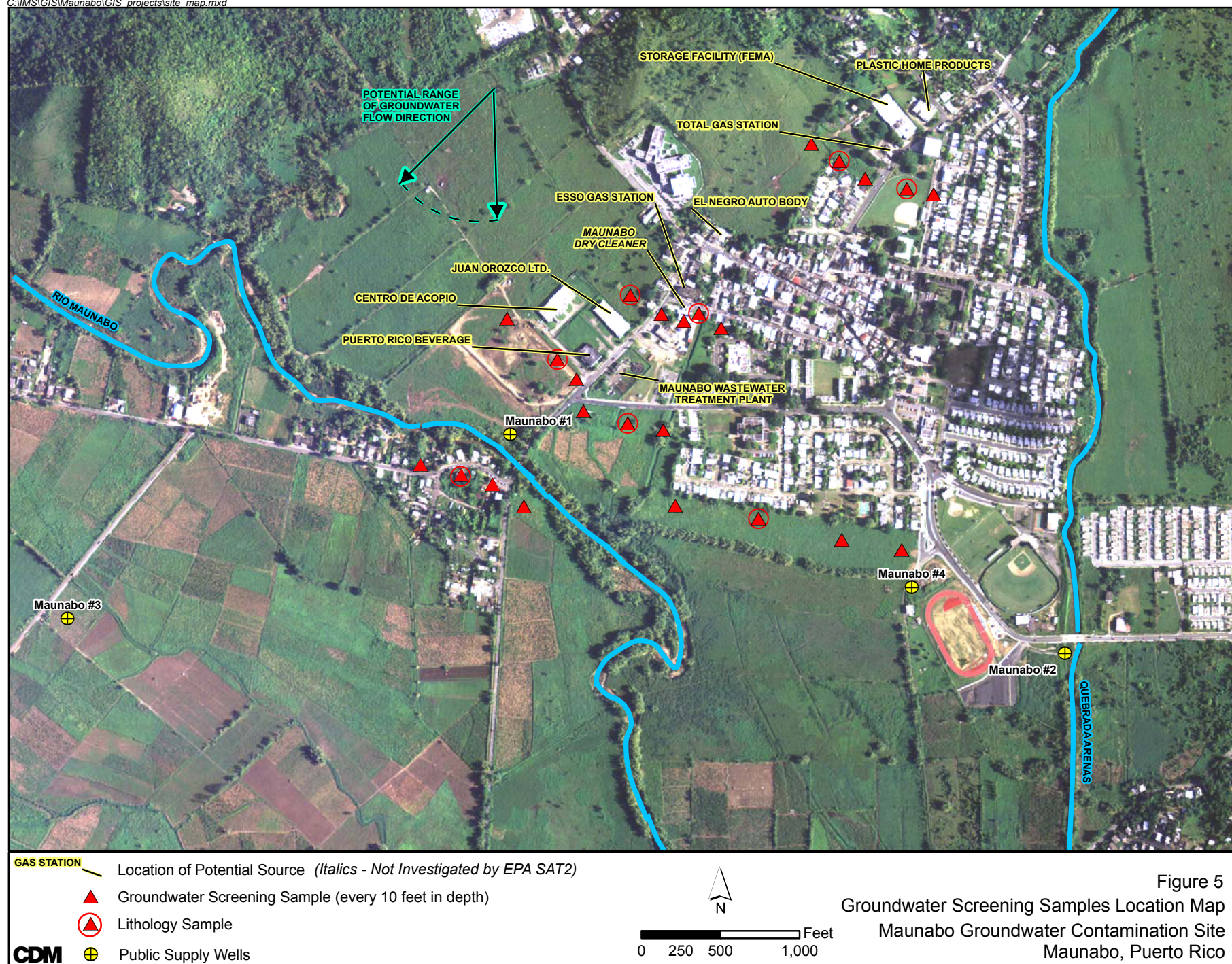
External Tasks

Project Summary

Group By Summary

Figure 4
Maunabo Groundwater Contamination Site
Project Schedule





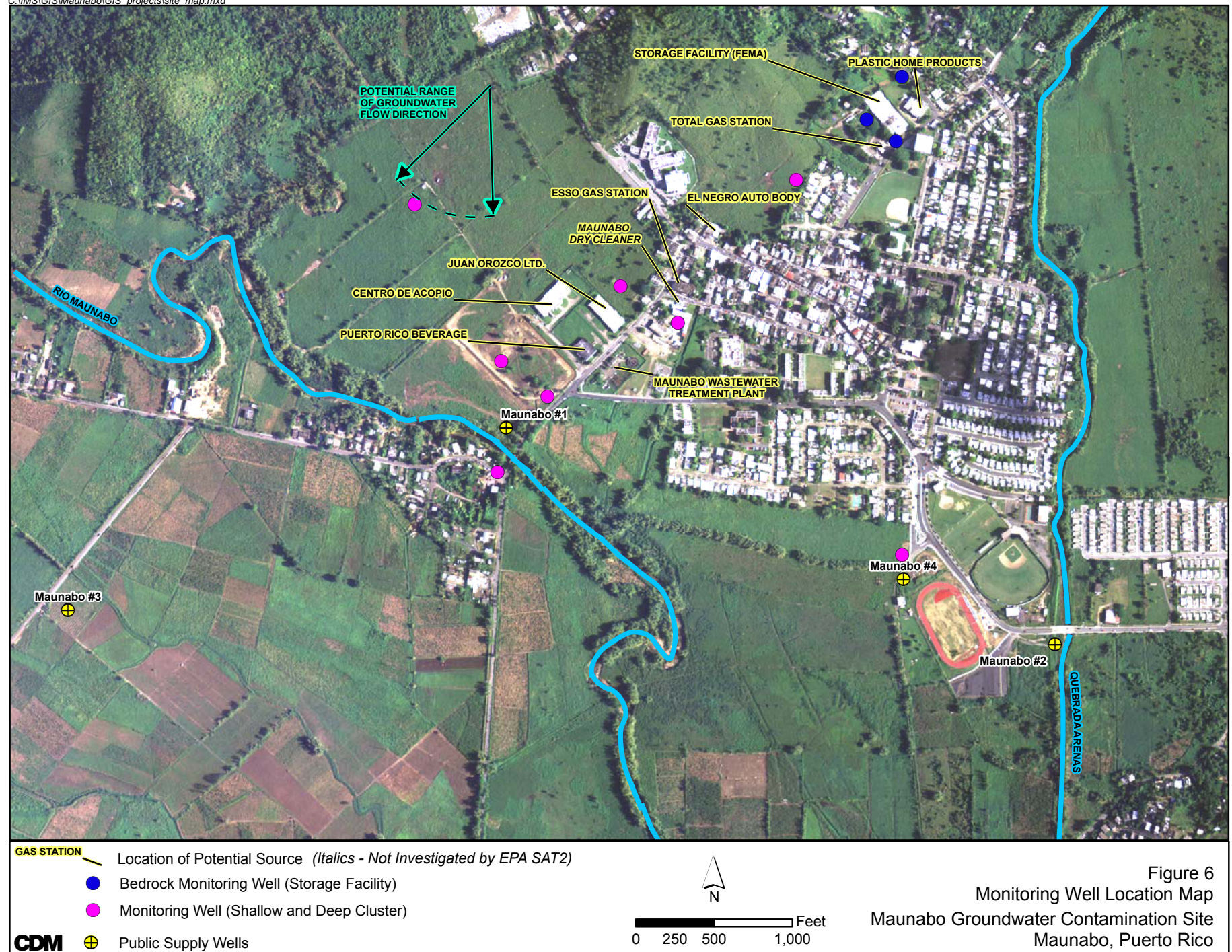
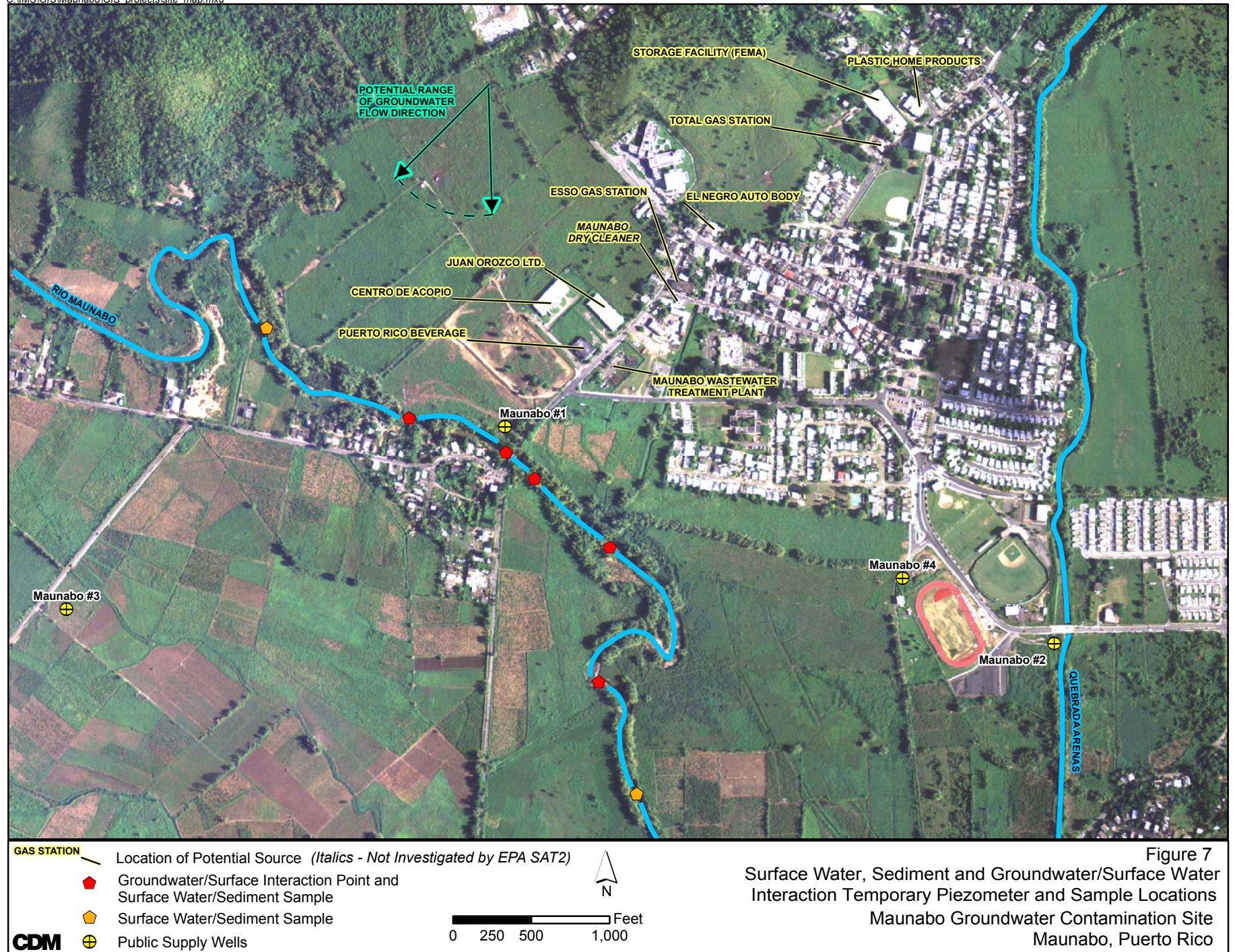


Figure 6
Monitoring Well Location Map
Maunabo Groundwater Contamination Site
Maunabo, Puerto Rico



A

Appendix A

APPENDIX A

**SITE-SPECIFIC LOW FLOW GROUNDWATER
PURGING AND SAMPLING PROCEDURE**

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUNDWATER SAMPLING PROCEDURE
LOW STRESS (LOW-FLOW) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II preferred method for collecting groundwater samples from monitoring wells at the Maunabo Groundwater Contamination Site. The procedure minimizes stress on the formation and minimizes disturbance of sediment in the well. The procedure applies to monitoring wells that have well casing with an inner diameter of 2.0 inch or greater. It is appropriate for groundwater samples that will be analyzed for volatile and semi-volatile organic compounds (VOC and SVOC), pesticides, polychlorinated biphenyls (PCB), metals, and microbiological and other contaminants in association with any EPA program.

This procedure does not address the collection of non-aqueous phase liquid (NAPL) samples and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The goal of the Low Stress Purging and Sampling procedure is to collect samples that are representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that allows a maximum drawdown of 0.3 foot.

Sampling at such a low flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing a filtered sample from the same well. Second, it minimizes aeration of the groundwater during sample collection, which improves the sample quality for VOC analysis. Third, in most cases it significantly reduces the volume of

groundwater purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of a key indicator parameter to stabilize; c) cascading of water and formation of air bubbles in the tubing; and d) cross-contamination.

For wells with insufficient yield (i.e., low recharge rate of the well), care should be taken to avoid loss of pressure in the tubing line, cascading through the sand pack, or pumping the well dry. Purging should be interrupted before the water level in the well drops below the top of the pump. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

If a key indicator parameter fails to stabilize after 4 hours, one of two options should be considered: a) continue purging in an attempt to achieve stabilization; or b) discontinue purging, collect samples, and document attempts to reach stabilization in the log book. The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

For cascading and air bubbles in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 inch ID) to ensure that the tubing remains filled with liquid during sampling.

An item that should be checked on a daily basis, is the water within the cooling chamber of the submersible pump. This chamber should always be filled with demonstrated analyte-free water and any leakage from this chamber should be immediately brought to the attention of the person(s) responsible for equipment maintenance so that the appropriate seals can be replaced. Operating the pump with insufficient water in this cooling chamber could result in the pump overheating and/or pump failure. The analyte-free water should be replaced on a daily basis in order to facilitate the mechanical operation of the pump.

IV. EQUIPMENT

- ☐ **Approved site-specific Quality Assurance Project Plan (QAPP).**
Generally, the target depth corresponds to just above the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake.
- ☐ Well construction data, location map, field data from last sampling event.
- ☐ Polyethylene sheeting.
- ☐ Photo Ionization Detector (PID).
- ☐ Adjustable rate, positive displacement groundwater sampling pump constructed of stainless steel.
- ☐ Interface probe or equivalent device for determining the presence or absence of NAPL.
- ☐ Teflon-lined polyethylene tubing to collect samples for organic and inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.
- ☐ Electronic water level measuring device, 0.01 foot accuracy.
- ☐ Flow measurement supplies (e.g., graduated cylinder and stop watch).
- ☐ Power source (generator).
- ☐ Monitoring instruments for indicator parameters. Redox potential (Eh) and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Temperature, pH and specific conductance may be monitored with an in-line monitor. A nephelometer is used to measure turbidity.
- ☐ Decontamination supplies (see Section VII, below).
- ☐ Logbook (see Section VIII, below).
- ☐ Sample bottles.
- ☐ Sample preservation supplies (as required by the analytical methods).
- ☐ Sample tags or labels, chain of custody.
- ☐ Other supplies as specified in the EPA approved field sampling plan/QAPP.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated groundwater and proceed systematically to the well with the most

contaminated groundwater. Check well for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for monitoring and sampling equipment.
3. Measure VOCs at the rim of the unopened well with a PID or FID instrument and record the reading in the field log book.
4. Remove well cap.
5. Measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field log book.
6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one.
7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled before any purging begins. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.
8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment which has accumulated at the bottom of the well. Record the observations in the log book.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to a depth midway within the screen interval for that well. The pump intake must be kept at least two feet above the bottom of the well to prevent disturbance and resuspension of any sediment or DNAPL present in the bottom of the well. Record the depth to which the pump is lowered.
10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. **Purge Well:** Start pumping the well with a rate that varies from 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every three to five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.
12. **Monitor Indicator Parameters:** During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every three to five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

±0.1 for pH
±3% for specific conductance (conductivity)
±10 mv for redox potential
±10% for DO and turbidity

Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

If pH adjustment is necessary for sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 mls). Groundwater purged from the well prior to sampling can be used for this purpose.

13. **Collect Samples:** Collect samples at flow rates of between 100 and 250 ml/min or such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. Samples should be collected at the same flow rate at which the indicator parameters stabilized. VOC samples must be collected first, at the lower rate, and directly into pre-preserved sample containers. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for re-sampling by hanging the tubing inside the well.
15. Measure and record well depth.
16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance was consulted when preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples will be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at frequency of one per sample cooler containing VOCs

- ☐ Field duplicate.
- ☐ Equipment blank (not necessary if equipment is dedicated to the well).
- ☐ Trip blank (VOCs only)

Groundwater samples should be collected systematically beginning at wells known or believed to have the lowest level of contamination and proceeding in order to wells known or believed to have the highest level of contamination.

VII. DECONTAMINATION

Sampling equipment must be decontaminated thoroughly each day before use (daily decon) and after each well is sampled (between-well decon). As noted above, wells should be sampled in order from the least contaminated to the most contaminated. Pumps should not be removed from the well between purging and sampling operations. All non-disposable equipment, including the pump (support cable and electrical wires which are in contact with the sample) will be decontaminated as described below.

17. Prior to Sampling Event Decon

Please Note: Steps D through K should only be performed once (for each pump that is to be used) before the commencement of a particular sampling event by a person qualified to disassemble pumps.

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

D) Disassemble pump.

E) Wash pump parts (inlet screen, shaft suction interconnector, motor lead assembly, stator house): Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water for five minutes.

G) Rinse the pump parts with demonstrated analyte-free water.

H) Place impeller assembly in a large glass beaker and rinse with 1 % nitric acid (HNO_3).

I) Rinse impeller assembly with potable water for five minutes.

J) Place impeller assembly in a large glass beaker and rinse with isopropanol.

K) Thoroughly rinse impeller assembly with demonstrated analyte-free water.

18. Daily and Between-Well Decon

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

D) Final Rinse: Operate pump in a deep basin of analyte-free water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

- ☐ Well identification number and physical condition.
- ☐ Well depth, and measurement technique.
- ☐ Static water level depth, date, time, and measurement technique.
- ☐ Presence and thickness of immiscible liquid layers and detection method.
- ☐ Collection method for immiscible liquid layers.
- ☐ Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- ☐ Well sampling sequence and time of sample collection.
- ☐ Types of sample bottles used and sample identification numbers.
- ☐ Preservatives used.
- ☐ Parameters requested for analysis.
- ☐ Field observations of sampling event.
- ☐ Name of sample collector(s).
- ☐ Weather conditions.
- ☐ QA/QC data for field instruments.
- ☐ Other logbook entries as required in the EPA approved field sampling plan/QAPP.

IX. REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

EPA, 1998, EPA Region II, Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, March 16.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

B

Appendix
B

APPENDIX B

CDM TECHNICAL STANDARD OPERATING PROCEDURES

1-1	Surface Water Sampling
1-2	Sample Custody*
1-3	Surface Soil Sampling*
1-4	Subsurface Soil Sampling*
1-5	Groundwater Sampling using Bailers
1-6	Water Level Measurement
1-8	VOC Air Sampling Using USEPA Method TO-15 With SUMMA® Canister
1-9	Tap Water Sampling*
1-10	Field Measurement of Organic Vapors
1-11	Sediment/Sludge Sampling*
2-1	Packaging and Shipping of Environmental Samples*
2-2	Guide to Handling of Investigation Derived Waste
3-1	Geoprobe® Sampling
3-2	Topographic Survey
3-4	Geophysical Logging, Calibration, and Quality Control
3-5	Lithologic Logging
3-6	Underground Facility Location
4-1	Field Logbook Content and Control*
4-2	Photographic Documentation of Field Activities
4-3	Well Development and Purging*
4-4	Design and Installation of Monitoring Wells in Aquifers*
4-5	Field Equipment Decontamination at Nonradioactive Sites*
4-6	Hydraulic Conductivity Testing
4-8	Environmental Data Management
5-1	Control of Measurement and Test Equipment *
PSOP-1	Passive Diffusion Bag Water Sampling

* Includes RAC II Contract-Specific Clarification

TSOP 1-1
SURFACE WATER SAMPLING

Surface Water Sampling

SOP 1-1
Revision: 7
Date: March 2007

Prepared: Del Baird

Technical Review: Curt Coover

QA Review: Jo Nell Mullins

Approved: 

Issued: 

Signature/Date

Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define requirements for collection and containment of surface water samples.

2.0 Background

Surface water samples are collected to determine the type(s) and level(s) of contamination in a particular surface water body and/or its biological disposition.

2.1 Definitions

Surface Water - Water that flows over or rests on the land and is open to the atmosphere. This includes ditches, streams, rivers, lakes, pools, ponds, and basins.

Shallow Surface Water - Water within 1 to 3.3 feet (0.3 to 1 meter) of the surface of a body of water.

Deep Surface Water - Water deeper than 3.3 feet (1 meter) of the surface of a body of water.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Simple Composite - Two or more subsamples taken from a specific media and site at a specific point in time. The subsamples are collected and mixed, and then a single average sample is taken from the mixture.

Temporal Composite - Two or more subsamples taken from a specific media and site over a period of time. The subsamples are collected and mixed, and then a single average sample is taken from the mixture.

Churn Splitter - Large vessel for compositing subsamples. Includes a mechanism to agitate the water to keep solids suspended.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-2, *Photographic Documentation of Field Activities*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this SOP, related SOPs, and the required equipment.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The FTL also must ensure that the quantity and location of surface water samples collected meet the requirements of the site-specific plans.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

All or part of the equipment listed under the “as needed” category may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans
- Field logbook
- Indelible black-ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or “blue ice”
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment
- Latex or appropriate gloves
- Rubber boots and/or rubberized waders
- Life jacket
- Kimwipe or paper towels
- Clean plastic sheeting
- Tap and deionized water
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies

As needed:

- Pond sampler with 1-liter (L) beaker (preferably Teflon®), clamp, and heavy-duty telescoping pole
- Weighted bottle sampler, 1-L capacity (preferably Teflon) and handle; see USGS Open File Report 2005-1087 for selection of sampler; a Kemmerer or Van Dorn sampler may be used if Teflon is not required
- Churn splitter
- Peristaltic pump or suitable replacement
- Temperature, pH, and conductivity meter(s), dissolved oxygen meter, redox potential meter (as required by project plan)
- Boat with depth finder for deep water or inaccessible shorelines
- Global positioning system (GPS) unit
- Tape measure
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment

5.0 Procedures

5.1 Preparation

The following steps should be taken when preparing for sampling surface water:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.
3. Select wadeable stream/river sampling locations that exhibit cross-sectional homogeneity and are well-mixed. Avoid areas where the channel is constricted or bends where scouring may have occurred. For lake samples, the investigator should consider the lake stratification caused by seasonal temperature differences. If possible, select a location that can be described precisely, such as xx feet upstream of xx bridge. Use caution when wading streams more than 1 to 2 feet deep. Flowing water can be a safety hazard.
4. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.
5. Make field measurements as required by the project plans in physical, chemical, and biological characteristics of the water (e.g., discharge, gage height, temperature, dissolved oxygen, conductivity, pH).

Surface Water Sampling

SOP 1-1
Revision: 7
Date: March 2007

6. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in 1 day, always collect from downstream to upstream.
7. The sampler should be facing upstream when sampling, both for proper sample collection and for safety (ability to observe floating objects).
8. Document the sampling events, recording all information in the designated field logbook and take photographs if required or if possible. Document any and all deviations from this SOP and include rationale for changes.
9. The collection points shall be located on a site map and described in the field logbook. Use GPS if required or if possible.
10. Label each sample container with the appropriate information. Secure the label by covering it with a piece of waterproof clear tape.
11. Decontaminate reusable sampling equipment after sample collection according to CDM Federal SOP 4 5.
12. Processes for verifying depth of samples must be included in site-specific project plans.
13. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control sample requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Shallow Surface Water Sample Collection for Wadeable Streams

5.2.1 Method for Collecting Samples for Volatile Organic Compound Analysis

All volatile organic compound (VOC) samples should be discrete samples. The following steps must be taken when collecting shallow surface water VOC samples:

If the volatile organic analysis (VOA) vials do not require a preservative:

1. Approach the sample location from downstream; do not enter the sample area. Slowly submerge VOA vials completely into an area of gently flowing water and fill. Do not disturb bottom sediments. The open end of the vials should be pointed upstream

Note: When collecting samples for VOC analysis, avoid collecting from a surface water point where water is cascading and aerating.

2. Cap the VOA vial while it is underwater. Be sure to dislodge all air bubbles from the cap before sealing the vial.
3. Turn the capped vial upside down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.
4. Proceed to Step 5 below.

If the VOA vials require a preservative:

1. Collect a sufficient sample in a clean glass jar as in Steps 1 and 2 above for unpreserved vials. Specific sampling devices to be used must be specified in site-specific plans.
2. Decant the sample immediately into prepreserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Tip vials slightly while filling to reduce turbulence until nearly filled. Then straighten vial to vertical for final filling. Ensure that a meniscus is raised above the lip of the vial before capping.

3. Cap each vial once the meniscus has formed.
4. Turn the capped vial upside down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.
5. Wipe the outside of sample vials with a Kimwipe or clean paper towel. Affix a completed sample label.
6. Place sample vial(s) in a zip-top plastic bag and seal the bag.
7. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Discrete Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

The following steps must be followed when collecting discrete shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Directly dip the sample container, with the opening facing upstream, into the surface water and fill. If wading is necessary, approach the sample location from downstream; do not enter the actual sample area. Do not disturb underlying sediments.
2. Filter samples if required by the site-specific plan.
3. Add appropriate preservatives to the sample containers if required and check pH.

Note: Use a separate container when field testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

4. Cap the sample containers and wipe the outer surfaces of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
5. Place sample container(s) in individual zip-top plastic bags, if possible, and seal the bags.
6. Immediately pack all samples into a chilled cooler.

5.2.3 Method for Collecting Simple Composite Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

If the QAPP requires the use of simple composite samples, then a sampler capable of collecting composite samples is required. For width and depth integrated (WDI) composite samples, a DH-48 or DH-81 are recommended, but the QAPP may specify an alternative. The following steps must be followed when collecting simple composite shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Record the gage height, if any, before and after sampling.
2. Select the number of width increments based on the requirements of the QAPP. Generally, small well mixed streams require few increments while large or poorly mixed streams require more increments.
3. For fewer than six width increments, subsample locations can be visually estimated. For more than five width increments, string a tape measure across the stream above the water surface to be able to accurately identify the subsample locations. Increments should be evenly spaced across the stream for equal width-integrated (EWI) sampling.

4. If depth-integrated sampling is required, collect a subsample at each width increment by submerging the sampler, orifice facing upstream, from the surface to near the bottom and back up to the surface again in an even steady motion. Do not disturb the sediment at the bottom. The sampler should be retrieved less than full. If the sampler is full, empty it and repeat the subsample collection.
5. If depth-integrated sampling is not required, submerge the sampler with the orifice facing upstream into the surface water and fill.
6. Empty the sampler into a churn splitter or temporary container for later splitting.
7. Repeat Steps 4 to 6 for each width increment.
8. If temporary containers were used, empty into churn splitter. Operate the churn splitter by moving the churn up and down in a steady motion fast enough to homogenize the sample without causing aeration. While the churn is in motion, fill the sample bottles from the tap on the churn.
9. Follow Steps 2 through 6 in Section 5.2.2.

5.2.4 Method for Collecting Temporal Composite Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

If the QAPP requires the use of temporal composite samples, this can be accomplished using a series of discrete samples collected by hand or an automated sampler, or using a series of simple composite samples. Refer to the preceding sections for collecting the subsamples. The compositing scheme can be time-based (e.g., once per hour for 4 hours) or time-discharge (or time gage height) based (e.g., once per hour until the gage height exceeds xx feet, then change to once per 15 minutes).

Because of the project-specific nature of temporal composite sampling, the specific requirements should be identified in the QAPP. The following are general steps to be followed to collect temporal composite samples:

1. Provide for a method of measuring discharge or gage height before, during, and after sample collection as required in the QAPP.
2. Select the number of time increments based on the requirements of the QAPP. If the time increments change based on a change in flow or water quality, specify the trigger, the new time increment, and any additional trigger to return to the previous increment.
3. Calculate the storage volume for the subsamples and provide a churn splitter of adequate size to contain the entire sample to be composited.
4. Collect the samples according to a method described in this SOP or alternate specified in the QAPP.
5. Provide for cold storage of subsamples, if possible. Do not process any subsamples by filtering or preserving unless specified in the QAPP.
6. Following collection of all subsamples, empty the containers into a churn splitter. If discrete data are required including laboratory or field analysis, retain a portion of the subsample.
7. Operate the churn splitter by moving the churn up and down in a steady motion fast enough to homogenize the sample without causing aeration. While the churn is in motion, fill the sample bottles from the tap on the churn.
8. Follow Steps 2 through 6 in Section 5.2.2.

9. Field parameters should be measured in the surface water at the time of collection. Some field parameters can be measured on the subsamples at the time of compositing, but the temperature and temperature-dependant parameters will not be representative.

5.3 Deep Surface Water Sample Collection

5.3.1 Method for Collecting Samples at Specified Depth Using a Weighted Bottle Sampler

The following steps must be followed when collecting surface water samples at specific depths using a weighted bottle sampler:

1. Lower the weighted bottle sampler to the depth specified in the site-specific plan.
2. Remove the stopper by pulling on the sampler line; allow the sampler to fill with water.
3. Release the sampler line to reseal the stopper and retrieve the sampler to the surface.
4. Wipe the weighted bottle sampler dry with a Kimwipe or clean paper towel.
5. Remove the stopper slowly. Fill the specified number of sample containers by slightly tipping the sampler against each sample bottle. Samples to be used for VOC analysis should be decanted directly from the sampler first into prepreserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Add appropriate preservatives to the other sample containers and check pH. Samples may be pooled in stainless steel, glass, or Teflon containers to obtain the necessary volumes. Filter samples if required. Collect sample in separate container for pH, conductivity, temperature, and other measurements if necessary.
6. Close each sample container with the Teflon-lined cap once it is filled. Check for air bubbles in the VOC sample containers. If bubbles are present, discard and resample.
7. Wipe the outside of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
8. Place sample container(s), if possible, in individual zip-top plastic bags, and seal the bags.
9. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Deep Surface Water Sample Collection Using a Peristaltic Pump

The following steps must be followed when collecting deep surface water samples using a peristaltic pump:

1. Install clean medical-grade silicon or Teflon tubing on the pump head. Leave sufficient tubing on the discharge side for convenient dispensing of liquid directly into sample containers.
2. Select the appropriate length of Teflon intake tubing necessary to reach the specified sampling depth. Attach the intake sampling tube to the intake pump tube.
3. Lower the intake tube into the surface water at the specified sampling location to the specified depth; make sure the end of the intake tube does not touch underlying sediments.
4. Start the pump and allow at least three tubing volumes of liquid to flow through and rinse the system before collecting any samples. Do not immediately dispense the purged liquid back to the surface water body. Instead, collect the purged liquid and return it to the source after sample collection is complete.
5. Fill the specified number of sample containers directly from the discharge line. Filter samples if required by the site-specific plan. While filling, allow the liquid to flow gently down the inside of the sample bottle to minimize turbulence.

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For VOC samples, fill prepreserved VOA vials and allow a meniscus to form above the top of the container before capping. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Check VOA vials to ensure that there are no air bubbles. Add appropriate preservatives to the other samples and check pH.

Note: Use a separate container when field-testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

6. Cap the sample container(s). Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
7. Place sample container(s) in individual zip-top plastic bags and seal the bags.
8. Immediately pack all samples into a chilled cooler.
9. Drain the pump system, rinse it with deionized water, and wipe it dry. Replace all tubing with new tubing before sampling at another sampling location. Place all used tubing in plastic bags to be discarded or decontaminated according to the site-specific plans.

6.0 Restrictions/Limitations

Peristaltic pumps are generally not capable of lifting water distances greater than 20 to 25 feet (6 to 7.5 meters) above the normal hydrostatic level.

Grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point and has been disturbed.

7.0 References

U. S. Department of Energy. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R1. July 1990 or current revision.

_____. Hazardous Waste Remedial Actions Program. *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R2. September 1996 or current revision.

U. S. Environmental Protection Agency, Region 2. *CERCLA Quality Assurance Manual*. March 1988 or current revision.

_____, Region 4. *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual*. May 1996 or current revision.

U. S. Geological Survey. *National Field Manual for the Collection of Water-Quality Data, Chapter A4*. September 1999.

_____. A guide to the Proper Selection and Use of Federally Approved Sediment and Water Quality Samplers. Open-File Report 2005-1087. 2005.

TSOP 1-2
SAMPLE CUSTODY

Sample Custody

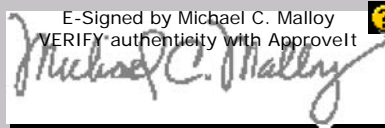
SOP 1-2
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Date: March 2007

Prepared: David O. Johnson

Technical Review: S. Budney

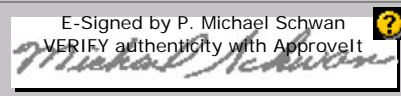
QA Review: Jo Nell Mullins

Approved:

E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt


Signature/Date

Issued:

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt


Signature/Date

1.0 Objective

Because of the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Federal Programs Corporation (CDM) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

Note: Sample custody documentation requirements vary with the specific EPA region or client. This SOP is intended to present basic sample custody requirements, along with common options. Specific sample custody requirements shall be presented in the project-specific quality assurance (QA) project plan or project-specific modification or clarification form (see Section U-1).

2.0 Background

2.1 Definitions

Sample - A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody - A sample is under custody if:

1. It is in your possession
2. It is in your view, after being in your possession
3. It was in your possession and you locked it up
4. It is in a designated secure area

Chain-of-Custody Record - A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another.

Custody Seal - A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label - A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag - A sample tag is attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

3.0 General Responsibilities

Sampler - The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontractor laboratory to

Sample Custody

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ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork.

Field Sample Custodian - The field sample custodian, when designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses. A field sample custodian is typically designated only for large and complex field efforts.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Supplies

- Chain-of-custody records (applicable client or CDM forms)
- Sample labels and/or tags
- EPA Field Operations Records Management System II Lite™ (FORMS II Lite™) software (if required)
- Printer paper
- Custody seals
- Clear tape
- Computer
- Printer

5.0 Procedures

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations before the actual fieldwork. As few people as possible shall handle samples.
2. Complete sample labels or tags for each sample using waterproof ink.
3. Maintain personal custody of the samples (in your possession) at all times until custody is transferred for sample shipment or directly to the analytical laboratory.

Transfer of Custody and Shipment

1. Complete a chain-of-custody record for all samples (see Figure 1 for an example of a chain-of-custody record. Similar forms may be used when requested by the client). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the sample custodian in the appropriate laboratory.
 - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the chain-of-custody record.
 - In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.
 - If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

Note: If a field sample custodian has been designated, he/she may initiate the chain-of-custody record, sign, and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher (refer to Figure 1).

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2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied by a separate chain-of-custody record. If a shipment consists of multiple coolers, a chain-of-custody record shall be filled out for each cooler documenting only samples contained in that particular cooler.
3. The original record will accompany the shipment, and the copies will be retained by the FTL and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the FTL as part of the permanent documentation. The shipping number from the freight bill shall be recorded on the applicable chain-of-custody record and field logbook in accordance with TSOP 4-1, *Field Logbook Content and Control*.

Procedure for Completing CDM Example Chain-of-Custody Record

The following procedure is to be used to fill out the CDM chain-of-custody record. The record provided herein (Figure 1) is an example chain-of-custody record. If another type of custody record (i.e., provided by the EPA Contract Laboratory Program (CLP) or a subcontract laboratory or generated by FORMS II Lite™) is used to track the custody of samples, the custody record shall be filled out in its entirety.

1. Record project number.
2. Record FTL for the project (if a field sample custodian has been designated, also record this name in the "Remarks" box).
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier's airbill number.
6. Record sample location number.
7. Record sample number.
8. Note preservatives added to the sample.
9. Note media type (matrix) of the sample.
10. Note sample type (grab or composite).
11. Enter date of sample collection.
12. Enter time of sample collection in military time.
13. When required by the client, enter the names or initials of the samplers next to the sample location number of the sample they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter appropriate designation for laboratory quality control (e.g., matrix spike/matrix spike duplicate [MS/MSD], matrix spike/duplicate [MS/D]), or other remarks (e.g., sample depth).
16. Sign the chain-of-custody record(s) in the space provided. All samplers must sign each record.
17. If sample tags are used, record the sample tag number in the "Remarks" column.
18. The originator checks information entered in Items 1 through 16 and then signs the top left "Relinquished by" box, prints his/her name, and enters the current date and time (military).
19. Send the top two copies (usually white and yellow) with the samples to the laboratory; retain the third copy (usually pink) for the project files. Retain additional copies for the project file or distribute as required to the appropriate sample coordinators.
20. The laboratory sample custodian receiving the sample shipment checks the sample label information against the chain-of-custody record. Sample condition is checked and anything unusual is noted under "Remarks" on the chain-of-custody record. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the copy. The white copy is returned to CDM.

5.2 Sample Labels and Tags

Unless the client directs otherwise, sample labels or tags will be used for all samples collected or accepted for CDM projects.

1. Complete one label or tag with the information required by the client for each sample container collected. A typical label or tag would be completed as follows (see Figure 2 for example of sample tag; labels are completed with the equivalent information):
 - Record the project code (i.e., project or task number).
 - Enter the station number (sample number or EPA CLP identification number) if applicable.
 - Record the date to indicate the month, day, and year of sample collection.
 - Enter the time (military) of sample collection.

Sample Custody

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- Place a check to indicate composite or grab sample.
 - Record the station (sample) location.
 - Sign in the space provided.
 - Place a check next to "yes" or "no" to indicate if a preservative was added.
 - Place a check under "Analyses" next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. Note: Do not write in the box for "laboratory sample number."
 - Place or write additional relevant information under "Remarks."
2. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.
 3. Securely attach sample tags to the sample bottle. On 2.27 liter (80 oz.) amber bottles, the tag string may be looped through the ring-style handle and tied. On all other containers, it is recommended that the string be looped around the neck of the bottle, then twisted, and relooped around the neck until the slack in the string is removed.
 4. Double-check that the information recorded on the sample tag is consistent with the information recorded on the chain-of-custody record.

5.3 Custody Seals

Two custody seals must be placed on opposite corners of all shipping containers (e.g., cooler) before shipment. The seals shall be signed and dated by the shipper.

Custody seals may also be required to be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction.

5.4 Sample Shipping

CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples* defines the requirements for packaging and shipping environmental samples.

6.0 Restrictions/Limitations

Check with the EPA region or client for specific guidelines. If no specific guidelines are identified, this procedure shall be followed.

For EPA CLP sampling events, combined chain-of-custody/traffic report forms generated with EPA FORMS II Lite™ or other EPA-specific records may be used. Refer to regional guidelines for completing these forms.

The EPA FORMS II Lite™ software may be used to customize sample labels and custody records when directed by the client or the CDM project manager.

7.0 References

U. S. Army Corps of Engineers. 2001. *Requirements for the Preparation of Sampling and Analysis Plan*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. Revised March 1992. *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p.85.

_____. Region IV. 1996. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Section 3.3. May.

_____. 2002. *FORMS II Lite™ User's Guide, Version 5.1*.

_____. 2002. *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5, EPA/240/R-02/009. Section 2.2.3. December.

_____. 2004. *Contract Laboratory Program (CLP), Guidance for Field Samplers*, EPA-540-R-00-003. Final. Section 3.2. August.

Figure 1
Example CDM Chain-of-Custody Record

CDM

125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123
Fax: (212) 785-6114

**CHAIN OF CUSTODY
RECORD**

PROJECT ID.		FIELD TEAM LEADER		LABORATORY AND ADDRESS				DATE SHIPPED				
PROJECT NAME/LOCATION				LAB CONTRACT:				AIRBILL NO.				
MEDIA TYPE		PRESERVATIVES		SAMPLE TYPE		ANALYSES (List no. of containers submitted)						
1. Surface Water 2. Groundwater 3. Leachate 4. Field QC 5. Soil/Sediment 6. Oil 7. Waste 8. Other _____		1. HCl, pH <2 2. HNO ₃ , pH <2 3. NaOH, pH >12 4. H ₂ SO ₄ , pH <2 5. Zinc Acetate, pH >9 6. Ice Only 7. Not Preserved 8. Other _____		G = Grab C = Composite								
SAMPLE LOCATION NO.	LABORATORY SAMPLE NUMBER	PRESERVATIVES ADDED	MEDIA TYPE	SAMPLE TYPE	20 _ DATE	TIME SAMPLED	REMARKS (Note if MS/MSD)					
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
10.												
SAMPLER SIGNATURES:												
RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME	RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME					
(SIGN)		(SIGN)		(SIGN)		(SIGN)						
RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME	RELINQUISHED BY: (PRINT)	DATE/TIME	RECEIVED BY: (PRINT)	DATE/TIME					
(SIGN)		(SIGN)		(SIGN)		(SIGN)						
COMMENTS:												

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers.

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Note: If requested by the client, different chain-of-custody records may be used. Copies of the template for this record may be obtained from the Chantilly Graphics Department.

Figure 2
Example Sample Tag

Designate:	Grab	Preservative: Yes <input type="checkbox"/> No <input type="checkbox"/>
	Comp.	
Time	Samplers (Signatures)	ANALYSES
		BOD Anions Solids (TSS) (TDS) (SS) COD, TOC, Nutrients Phenolics Mercury Metals Cyanide Oil and Grease Organics GC/MS Priority Pollutants Volatile Organics Pesticides Mutagenicity Bacteriology
Month/Day/Year	Station Location	Remarks:
Station No.		
Project Code		
Tag No.		Lab Sample No.
3-3023215		

Note: Equivalent sample labels or tags may be used.

TSOP 1-3
SURFACE SOIL SAMPLING

Surface Soil Sampling

SOP 1-3
Revision: 6
Date: March 2007

Prepared: Del R. Baird

Technical Review: Mark Caldwell

QA Review: Jo Nell Mullins

Approved: 

Issued: 

Signature/Date

Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define the techniques and requirements for the collection of surface soil samples.

2.0 Background

The techniques and protocols described herein may be used to collect other surface media, including sediment and sludge.

2.1 Definitions

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Spoon/Scoop - A small stainless steel or Teflon[®] utensil approximately 15 cm (6 inches) in length with a stem-like handle.

Surface Soil - Soils generally defined as the soils extending from ground surface to approximately 30 centimeters (cm) (1 foot) below ground surface (bgs). Surface soil samples are frequently collected from 0 to 15 cm (0 to 6 inches) bgs. Depending on application, the soil interval to be sampled will vary.

Trowel - A small stainless steel or Teflon shovel approximately 15 to 20 cm (6 to 8 inches) in length with a slight (approximately 140°) curve across the length. The trowel has a stem-like handle (for hand operation). Samples are collected with a spooning action.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

Surface soil samples are collected to determine the type(s) and level(s) of contamination and are often important to risk assessment. These samples may be collected as part of an investigative plan, site-specific sampling plan, and/or as a screen for "hot spots," which may require more extensive sampling.

Sediment(s) and sludge(s) that have been exposed by evaporation, stream rerouting, or any other means are collected by the same methods as those for surface soil(s). Typically the top 1 to 2 cm of material are carefully removed before collection of the sample. If a thick, matted root zone is encountered at or near the surface, it shall be removed before collecting the sample.

Surface soil, exposed sediment, or sludge is collected using stainless steel and/or Teflon-lined trowels or scoops.

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of surface soil samples collected meet the requirements of the site-specific plans.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect surface soil samples in accordance with this procedure and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

- Insulated cooler and clear waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon-lined spatulas and pans, trays, or bowls
- Stainless steel and/or Teflon-lined trowels or spoons (or equipment as specified in the site-specific plans)
- Plastic sheeting
- Project plans (work plan/health and safety plan)
- Appropriate sample containers
- Field logbook
- Indelible black ink pen and/or marker
- Sample chain-of-custody forms
- Custody seals
- Decontamination supplies

Additional equipment is discussed in Section 5.2.2, VOC Field Sampling/Preservation Methods.

5.0 Procedures

5.1 Preparation

The following steps must be followed when preparing for sample collection:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.
3. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.
4. Processes for verifying depth of sampling must be specified in the site-specific plans.
5. Place clean plastic sheeting on a flat, level surface near the sampling area, if possible, and place equipment to be used on the plastic; place the insulated cooler(s) on separate plastic sheeting.
6. A clean, decontaminated trowel, scoop, or spoon will be used for each sample collected. Other equipment may be used (e.g., shovels) if constructed of stainless steel.

5.2 Collection

The following general steps must be followed when collecting surface soil samples:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Surface soil samples are normally collected from the least contaminated to the most contaminated areas, if known.

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3. Document the sampling events, recording the information in the designated field logbook. Document any and all deviations from SOPs in the field logbook and include rationale for changes. See CDM Federal SOP 4-1.
4. Carefully remove stones, vegetation, snow, etc. from the ground surface in the immediate vicinity of the sampling location.
5. First collect required sample aliquot for volatile analyses, as well as any other samples that would be degraded by aeration. Follow with collection of samples for other analyses.
6. Decontaminate sampling equipment between sample locations. See CDM Federal SOP 4-5.

5.2.1 Method for Collecting Samples for Volatile Organic Compound Analysis

The requirements for collecting grab samples of surface soil for volatile organic compounds (VOCs) or other samples degraded by aeration are as follows:

1. VOC samples shall be collected with the least disturbance possible.
2. VOC samples shall be collected as grab samples; however, the method of collection will vary from site to site, based on data quality objectives and the degree of known or suspected contamination.
3. Complete sample label by filling in the appropriate information and securing the label to the container. Cover the sample label with a piece of clear tape.
4. Use a clean stainless steel or Teflon-lined trowel or spoon (or tube) to collect sufficient material in one grab to fill the sample containers.
5. With the aid of a clean stainless steel spatula, quickly fill the sample containers directly from the sampling device, removing stones, twigs, grass, etc., from the sample. Fill the containers as full and compact as possible to minimize headspace.
6. Immediately secure the Teflon-lined cap(s) on the sample container(s).
7. Wipe the containers with a clean Kimwipe or paper towel to remove any residual soil from the exterior of the container.
8. Place the containers in individual zip-top plastic bag(s) and seal the bag(s).
9. Pack all samples as required. Include properly completed documentation and affix signed and dated custody seals to the cooler lid. See CDM Federal SOPs 1-2 and 2-1.

Note: A trip blank shall be included with sample coolers containing VOC samples. QC sample requirements vary from project to project. Consult the project-specific work plan for requirements.

5.2.2 VOC Field Sampling/Preservation Methods

The following four sections contain SW-846 test methods for sampling and field preservation. These methods include EnCore™ Sampler Method for low-level analyses, EnCore Sampler Method for high-level analyses, acid preservation for low-level analyses, and methanol preservation for high-level analyses. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust “wet” concentration results to “dry” concentrations to meet analytical method requirements.

Note: Some variations from these methods (e.g., sample volume) may be required depending on the contracted analytical laboratory.

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5.2.2.1 EnCore Sampling Equipment and Collection for Low Level Analyses (<200 µg/kg)

The following equipment is required for low-level analysis:

- Three 5-gram (g) samplers

Note: The sample volume requirements are general requirements. Actual sample volumes, sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce) wide-mouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting low level analysis (<200 µg/kg) by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sampler and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into a freshly exposed surface of soil until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
4. Extract the sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.
5. Push cap on with a twisting motion to secure to the sampler body.
6. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.
7. Fill out sample label and attach to sampler.
8. Repeat procedure for the remaining two samplers.
9. Collect moisture sample in 110-mL (4-ounce) wide-mouth jar using a clean stainless steel spoon or trowel.
10. Store samples at 4° Celsius (C), (±2°C). Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.2.2 Acid Preservation Equipment and Sampling Requirements for Low Level Analyses (<200 µg/kg)

Note: Determine specific field acid preservation procedure based on the requirements specified in the analytical method to be employed. Variations between analytical methods exist with respect to field acid preservation.

The following equipment and supplies are required if field acid preservation is required:

- One 40-mL VOA vial with acid preservation (for field testing of soil pH)
- Two preweighed 40-mL VOA vials with acid preservative and stir bar (for lab analysis)
- Two preweighed 40-mL VOA vials with water and stir bar (in case samples cannot be pre-preserved)
- One preweighed jar that contains methanol or a preweighed empty jar accompanied with a preweighed vial that contains methanol (for screening sample and/or high level analysis)
- One 110-mL (4-oz) wide-mouth glass jar or applicable container for moisture analysis
- One 55-mL (2-oz) jar with acid preservative (if additional acid is needed because of high soil pH)
- One appropriately sized scoop capable of delivering 1 g of solid sodium bisulfate
- pH paper
- Weighing scale capable of reading to 0.01 g

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- Set of balance weights used in daily balance calibration
- Gloves for working with preweighed sample vials
- Paper towels
- Sodium bisulfate acid solution (NaHSO_4)
- A cutoff plastic syringe or other coring device capable of collecting sufficient sample volume (5 g)

Testing Effervescing Capacity of Soils

Soils must be tested with acid to determine the amount of effervescing that will occur when preserved with acid. Effervescing will drive off VOCs as well as create a high pressure in a sealed vial that could result in the explosion of the sample container. The following steps provide information on the effervescing capacity of the soil.

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Place approximately 5 g of soil into a vial that contains acid preservative and no stir bar.
3. Do not cap this vial as it may EXPLODE upon interaction with the soil.
4. Observe the sample for gas formation (due to carbonates in the soil).
5. If vigorous or sustained gas emissions are observed, then acid preservation is not acceptable to preserve the sample.
 - In this case the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.
6. If a small amount or no gas formation occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering test detailed below.
 - In this case the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

Testing Buffering Capacity of Soils

The soils must be tested to determine the quantity of acid that is required to achieve a pH reading of ≤ 2 standard units (SUs). The following steps will assist in determining this quantity.

1. If acid preservation is acceptable for sampling soils, then the sample vial that was used to test the effervescing capacity of the soils can be used to test the buffering capacity.
2. Wear clean gloves during handling of all sample containers and sampling devices.
3. Cap the vial that contains 5 g of soil, acid preservative, and no stir bar from Step 1 in the effervescing test.
4. Shake the vial gently to homogenize the contents.
5. Open the vial and check the pH of the acid solution with pH paper.
 - If the pH paper reads below 2, then the sampling can be done in the two preweighed 40-mL VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.
 - If the pH paper reads above 2, then additional acid needs to be added to the sample vial.
6. Use the jar with the solid sodium bisulfate acid and add another 1 g of acid to the sample.
7. Cap the vial and shake thoroughly again.
8. Repeat Step 4.
 - If the pH paper reads below 2, then the sampling can be done in the two preweighed 40-mL VOA vials with the acid preservative and stir bar and 1 g extra of acid.

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- Make a note of the extra gram of acid needed so the same amount of acid can be added to the vials the lab will analyze.
- If the pH paper reads above 2, repeat Steps 5 through 7 until the sample pH ≤ 2 SUs.

Now that the soil chemistry has been determined, the actual sampling can occur. The procedure stated below assumes the correct vials are used based on the guidance discussed.

Sample Preservation Steps

1. Wear clean gloves during all handling of preweighed vials.
2. Add more acid if necessary (based on the buffering capacity testing discussed in the previous section).
3. Quickly collect a 5-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g of soil from a freshly exposed surface of soil.
4. Carefully wipe exterior of sample collection device with a clean paper towel.
5. Quickly transfer the sample to the appropriate VOA vial, using caution when extruding the sample to prevent splashing of the acid within the vial.
6. Remove any soil from the threads of the sample vial using a clean paper towel.
7. Cap vial and weigh the jar to the nearest 0.01 g.
8. Record exact weight on sample label.
9. Repeat sampling procedure for the duplicate VOA vial.
10. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation below.
11. Take the empty jar or the jar that contains the methanol preservative and quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size is dependent on who is doing the sampling and requirements specified by the client or analytical laboratory.
12. Carefully wipe the exterior of the collection device with a clean paper towel.
13. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial.
14. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
15. Remove any soil from the threads of the sample vial using a clean paper towel and cap the jar.
16. Weigh the jar with sample to the nearest 0.01 g and record the weight on the sample label.
17. Collect dry weight sample using a clean stainless steel spoon or trowel.
18. Store samples at 4°C, $\pm 2^\circ\text{C}$.
19. Ship sample containers to the analytical laboratory with plenty of ice and in accordance with Department of Transportation (DOT) regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

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5.2.2.3 EnCore Sampling Equipment and Sampling Requirements for High Level Analysis ($\geq 200 \mu\text{g/kg}$)

The following equipment is required for high-level analysis:

- One 5-g sampler or one 25-g sampler

Note: The volume requirements specified are general requirements. Actual sample volumes, container sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-mL (4-oz) wide-mouth glass jar or applicable container specified for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting high level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sample and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into freshly exposed surface of soil until the O-ring is visible within the hole/window on the side of the T-handle. If the O-ring is not visible within the window/hole, then the sampler is not full.
4. Use a clean paper towel to quickly wipe the sampler head so that the cap can be tightly attached.
5. Push cap on with a twisting motion to secure to the sampler body.
6. Fill out sample label and attach to sampler.
7. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.
8. Collect moisture sample in 110-mL (4-oz) wide-mouth glass jar or designated container using a clean stainless steel spoon or trowel.
9. Store samplers at 4°C , $\pm 2^{\circ}\text{C}$. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.2.4 Methanol Preservation Equipment and Sampling Requirements for High Level Analyses ($\geq 200 \mu\text{g/kg}$)

The following equipment is required for high-level analysis:

- | | |
|--|--|
| ■ One preweighed jar that contains methanol or a preweighed empty jar accompanied with a preweighed vial that contains methanol (laboratory grade) | ■ Set of balance weights used in daily balance calibration |
| ■ One dry weight cup | ■ Latex gloves |
| ■ Weighing balance that accurately weighs to 0.01 g | ■ Paper towels |
| | ■ Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil |

The requirements for sampling and preservation are as follows:

1. Wear clean gloves during all handling of preweighed vials.
2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.

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3. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil.
4. Carefully wipe the exterior of the collection device with a clean paper towel.
5. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.
6. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
7. Remove any soil from the exterior of the vial using a clean paper towel and cap the sample jar.
8. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.
9. Collect a dry weight sample using a clean stainless steel spoon or trowel.
10. Store samples at 4°C, $\pm 2^\circ\text{C}$.
11. Ship sample containers with plenty of ice to the analytical laboratory in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis

The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Label each sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.
3. Use a decontaminated stainless steel or Teflon-lined trowel or spoon to obtain sufficient sample from the required interval and subsampling points, if necessary, to fill the specified sample containers.
4. Empty the contents of the sampling device directly into a clean stainless steel or Teflon-lined tray or bowl.
5. Homogenize the sample by mixing with a spoon, spatula, or trowel.
6. Use the spoon, spatula, or trowel to distribute the uniform mixture into the labeled sample containers. Fill organic sample containers first, then inorganics.
7. Secure the appropriate cap on each container immediately after filling it.
8. Wipe the sample containers with a clean Kimwipe or paper towel to remove any residual soil.
9. Place sample containers in individual zip-top plastic bags and seal the bags.
10. Pack all samples as required. Include properly completed documentation and affix custody seals to the cooler lid.
11. Decontaminate sampling equipment according to CDM Federal SOP 4-5.

6.0 Restrictions/Limitations

When grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

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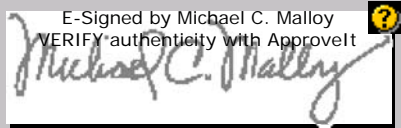
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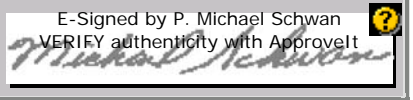
QA Review: Jo Nell Mullins

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VERIFY authenticity with ApproveIt


Signature/Date

Issued:

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1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples from the unconsolidated zone. Techniques include use of hand augers, split-barrel samplers, Shelby tubes, direct-push rig samplers, and backhoes.

2.0 Background

2.1 Definitions

Auger Flight - A steel section length attached to the auger length to extend the augers and remove additional unconsolidated material as drilling depth increases.

Backhoe - An excavator whose shovel bucket is attached to a hinged boom and is drawn backward to move earth.

Direct Push Rig Sampler - A sampler with a locking tip that keeps the device closed during the sampling push. The tip is released at the desired depth, and the push is continued. During the push, the soil moves into the sampler.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Hand Auger - A stainless steel cylinder (bucket) approximately 7 to 10 centimeters (cm) (3 to 4 inches) in diameter and 30 cm (1 foot) in length, open at both ends with the bottom edge designed to twist into the unconsolidated material and obtain a soil core. The auger has a T-shaped handle (used for manual operation) attached to the top of the bucket by extendable stainless steel rods.

Liner - A cylindrical sleeve generally made of brass, stainless steel, or Teflon® that is placed inside a split-barrel sampler, direct-push rig sampler, or hand auger bucket to collect samples for VOC analysis or prevent cross-contamination of the sample.

Shelby Tube - A cylindrical sampling device, generally made of steel, that is driven into the subsurface soil through a hollow-stem auger using a drill rig. The tube, once retrieved, may be capped and the undisturbed soil sample extruded in the laboratory before analysis.

Slide Hammer - A device consisting of a drive weight (hammer) and a drive weight fall guide.

Split-Barrel Sampler - A cylindrical sampling device generally made of carbon steel that fits into a hollow-stem auger. The sampler is opened lengthwise, which allows the sample to be retrieved by "splitting" the barrel sampler. Also referred to as a split-spoon.

Subsurface Soil - The unconsolidated material that exists deeper than approximately 30 cm (1 foot) below the ground surface.

Unconsolidated Zone - A layer of nonlithified earth material (soil) that has no mineral cement or matrix binding its grains.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

Shallow subsurface soil samples (to depths between 0.15 cm to 3 meters (m) [6 inches and 10 feet]) may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those collected by split-barrel or Shelby tube samplers because the soil sample is disturbed in the augering process. Split-barrel and Shelby tube samplers are generally used during collection of soil samples using hollow-stem auger drill methods. Barrel-type samplers may also be used to collect soil samples from hand auger borings using a slide hammer device. Liners are used to minimize the loss of volatile organic compounds (VOCs) and to prevent cross-contamination from the sampler to the sample. The size and material of sampling devices shall be selected based on project and analytical objectives and defined in site-specific plans. Collecting samples using backhoes enables the collector to correlate the precise vertical and horizontal interval with adjacent materials (cross section).

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and the required equipment, and for ensuring that subsurface soil samples are collected in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of subsurface soil samples collected meet the requirements of the site-specific plans.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with this SOP and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Required Equipment

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Clear, waterproof tape
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler(s) and waterproof sealing tape
- Ice bags or "blue ice"
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Plastic sheeting
- Stainless steel and/or Teflon-lined spatulas and pans, trays, bowls, trowels, or spoons
- Decontamination supplies
- Sample chain-of-custody forms
- Custody seals

Additional equipment is discussed in Section 5.2.7, Field Sampling/Preservation Methods.

4.2 Manual (Hand) Augering

- T-handle
- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers
- Slide hammer with extension rods

4.3 Split-Barrel and Shelby Tube Sampling

- Drill rig equipped with a 63-kilogram (kg) (140-lb) drop hammer and sufficient hollow-stem auger flights to drill to the depths required by the site-specific plans.
- Sufficient numbers of split-barrel samplers so that at least one is always decontaminated and available for sampling. Three split-barrel samplers are generally the minimum necessary (Shelby tubes are used only once).
- Split-barrel liners (as appropriate).
- Wrench(es), hammer.

4.4 Direct Push Rig Sampling

- Direct push rig with sufficient probe rods to extend to sample depths required by the site-specific plans
- Sufficient number of samplers (in case of malfunction) and appropriate liners to collect adequate number of samples
- Extension rods
- Wrench(es), pliers, other specific tools

4.5 Backhoe Sampling

- Backhoe with a sufficient length boom to extend to planned depths
- Sufficient number of trowels or scoops
- Extension rods
- Tape, utility knife, other specific tools as needed

5.0 Procedures

5.1 Preparation

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.
3. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.
4. Processes for verifying depth of sampling must be specified in the site-specific plans.
5. Clear away vegetation and debris from the ground surface at the boring location.
6. Prepare an area next to the sample collection location for laying out cuttings by placing plastic sheeting on the ground to cover the immediate area surrounding the borehole.
7. Set up a decontamination line, if decontamination is required, in accordance with CDM Federal SOP 4-5.

5.2 Collection

The following general steps must be followed when collecting all subsurface soil samples:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. VOC samples or samples that may be degraded by aeration shall be collected first and with the least disturbance possible.
3. Sampling information shall be recorded in the field logbook and on any associated forms. Describe lithology, according to CDM Federal SOP 3-5, in the field logbook or on the lithologic log form.
4. Specific sampling devices to be used shall be identified in the site-specific plans and recorded in the field logbook.

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5. Care must be taken to prevent cross-contamination and misidentification of samples.
6. Sample containers containing samples for VOC analysis shall be filled completely to minimize headspace.

5.2.1 Manual (Hand) Augering

The following steps must be followed when collecting hand-augered samples:

1. Auger to the depth required for sampling. Place cuttings on plastic sheeting or as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.
2. Throughout the augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.
3. Cease augering when the top of the specified sampling depth has been reached. If required, remove the auger from the hole and decontaminate the auger or use a separate decontaminated auger, then obtain the sample.
4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration) immediately and place in sample container. Sample bottles shall be filled completely to minimize headspace.
5. Remaining sample shall be homogenized for other analyses before placing samples in the appropriate containers. Label containers as required.
6. Wipe containers with a clean Kimwipe or paper towel to remove residual soil from the exterior of the container(s).
7. Label the sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.
8. Place the containers in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice.
9. Proceed with further sampling, as required by the site-specific plans.
10. When all sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
11. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before leaving the site.
12. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.2 Manual (Hand) Augering Using a Tube Sampler with Liner or Slide Hammer

The following steps must be followed when collecting hand-augered samples using a tube sampler with liner or slide hammer:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.
2. Throughout augering, make detailed notes in the field logbook concerning the geologic features of the soil or sediments.
3. Cease augering when the top of the specified sampling depth has been reached. Remove the auger from the hole and decontaminate.
4. Prepare a decontaminated tube sampler by installing a decontaminated liner in the auger tube.

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5. Obtain the sample by driving the sample tube through the sample interval with the slide hammer. Remove the liner from the tube and immediately cover the ends with Teflon tape and cap the ends of the tube. Seal the caps with waterproof tape.
6. Wipe sealed liners with a clean Kimwipe or paper towel.
7. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner.
8. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.
9. Proceed with further sampling, as required by the site-specific plans.
10. When sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
11. Decontaminate all equipment according to CDM Federal SOP 4-5 between each sample.
12. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.
13. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.3 Split-Barrel Sampling

Note: Steps 1 through 12 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting split-barrel samples:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location before drilling, per CDM Federal SOP 4-5 or the site-specific decontamination procedures.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s) to the drill rig.
4. Begin drilling and proceed to the first designated sample depth, adding auger flights as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods, if applicable.
7. If required by the site-specific sampling plan, install decontaminated liners in the split barrel sampler.
8. Install a decontaminated split-barrel on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
9. Mark the center rod in 15-cm (6-inch) increments from the top of the auger(s).
10. Drive the split-barrel using the hammer. Use a full 76-cm (30-inch) drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the sampler through each 15-cm (6-inch) increment.
11. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little or no progress is made for 50 blows of the hammer. ASTM D1586-99 § 7.2.1 and 7.2.2 defines "refusal" as >50 blows per 6-inch advance or a total of 100 blows.

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12. Pull the sampler free by using upswings of the hammer to loosen the sampler. Pull out the center rod and sampler.
13. Unscrew the sampler assembly from the center rod and place it on the plastic sheeting.
14. Remove the drive shoe and head assembly. If necessary, tap the sampler assembly with a hammer to loosen threaded couplings.
15. With the drive shoe and head assembly off, open (split) the sampler, being careful not to disturb the sample.
16. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape. If liners were used, immediately install Teflon tape over the ends of the liners, cap the liners, and seal the caps over the ends of the liner with waterproof tape. Label the samples as required by the site-specific plans. Mark the top and bottom of each sample on the outside of each liner. Indicate boring/well number and depth on the outside of the liner, as required.
17. If VOC analyses are to be conducted on the soil sample and liners were not used, place that sample in its sample container immediately after opening the split-barrel, filling the sample bottle completely. Seal the container immediately, then describe it in the field logbook and/or associated forms. Record the sample identification number, depth from which the sample was taken, and the analyses to be performed on the samples in the field logbook and on the appropriate forms.
18. Remaining sample shall be homogenized before placing samples in appropriate containers.
19. Wipe containers with a clean Kimwipe or paper towel. Label containers as required when liners are not used.
20. Place containers and/or sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.
21. In the field logbook and on the boring log, describe sample lithology by observing cuttings and/or the bottom end of the liner.
22. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
23. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.
24. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans. Backfill borehole as specified in project-specific plans.
25. Decontaminate samplers and other small sampling equipment according to CDM Federal SOP 4-5 before proceeding to other sampling locations.
26. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.
27. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

5.2.4 Shelby Tube Sampling

Note: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not CDM personnel. ASTM D1586-99 provides more details pertaining to this sampling methodology.

The following steps must be followed when collecting samples using the Shelby tube:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location before drilling.

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3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger(s) as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods, if applicable.
7. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby tube assembly to the center rods.
8. Lower the Shelby tube and center rods into the hollow-stem augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.
9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube shall be pushed with a slow, steady force. Note the pressure used to push the Shelby tube in the field logbook.
10. When the Shelby tube has been advanced to its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, slightly twist to break off the sample, and pull the apparatus out of the hole with the rig winch.
11. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.
12. Since the typical intent of Shelby tube sampling is for engineering purposes and an undisturbed sample is required, the tube ends shall be sealed immediately. Sealing is accomplished by filling any void space in the tube with melted beeswax, then placing caps on the ends of the tube and taping caps into place. The top and bottom ends of the tube shall be marked and the tube transported to the laboratory in an upright position. ***It is extremely important that the Shelby tube samples are not disturbed in any way (dropped, rolled, subjected to extreme temperatures, etc.).***
13. Wipe sealed tubes with a clean Kimwipe or paper towel.
14. Indicate boring/well number and depth on outside of the tube.
15. Place sealed tubes in zip-top plastic bags, seal bags, and pack samples in a chilled cooler, if applicable.
16. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
17. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.
18. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
19. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

5.2.5 Direct Push Rig Sampling

Note: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting samples using a direct push rig sampler:

1. Verify that the push rig has been decontaminated at a separate location before drilling.
2. Attach the properly assembled sampler with appropriate liner to the end of the probe rod.

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3. Attach drive cap and probe to the first designated sample depth, adding rod(s) as necessary.
4. Upon reaching the designated sample depth, remove the drive cap to access the inside of the probe rods.
5. Insert extension rods into probe rod; turn extension rod to release tip.
6. Retrieve extension rods, replace drive cap, add additional push rod if required, and push probe rod to the planned sample interval.
7. Attach pull cap and retrieve push rods and sampler.
8. Remove the sampler from the probe rod, then remove the cutting shoe from the sampler.
9. Once the cutting shoe is removed, the liner, containing the sample, can be removed from the sampler. The sample can now be handled per site-specific plans.
10. When sample collection is complete, remove the push rig to the heavy equipment decontamination area.
11. Dispose of excess sample cuttings, plastic sheeting, etc., as specified in the site-specific plans.
12. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

5.2.6 Backhoe Sampling

Note: Steps 1, 2, 7, and 8 describe activities to be performed by a licensed heavy equipment operator, not CDM personnel.

The following steps must be followed when collecting samples using a backhoe:

1. Verify that the backhoe has been decontaminated at a separate location before excavation.
2. Excavate to the depth required.
3. Use a stainless steel trowel or scoop.
4. Attach the trowel to an electrical conduit, steel rod, or other similar devise.
5. Remove the surface layer of soil "smeared" on the trench wall.
6. Replace the trowel with a clean trowel and collect the sample.
7. When sample collection is complete in the trench, backfill the trench with the excavated material, if allowed.
8. Once the trench has been backfilled, move the backhoe to the heavy equipment decontamination area.
9. Dispose of excess sample cuttings, plastic sheeting, etc., as specified in the site-specific plans.
10. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

5.2.7 Field Sampling/Preservation Methods

The following three sections contain SW 846 Methods for sampling and field preservation. These methods include EnCore™ Sampler Method for low-level detection limits, EnCore Sampler Method for high-level limits/screening, and methanol preservation. These methods may be used if required by the EPA Region, client, or governing sample plan. These methods are very detailed and contain equipment requirements at the beginning of each section.

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When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust “wet” concentration results to “dry” concentrations to meet analytical method requirements.

Note: Some variations from these methods, (e.g., sample volume) may be required depending on the contracted analytical laboratory.

5.2.7.1 EnCore Sampler Equipment and Collection Requirements for Low-Level Analyses (<200 µg/kg)

The following equipment is required for low-level analysis:

- Three 5 grams (g) samplers

Note: The sample volume requirements specified are general requirements. Actual sample volume and/or container sizes may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce [oz.]) wide-mouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting low level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sampler and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
4. Extract sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.
5. Push cap on with a twisting motion to secure to the sampler body.
6. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.
7. Fill out sample label and attach to sampler.
8. Repeat procedure for the remaining two samplers.
9. Collect moisture sample in 110-mL (4-oz.) wide-mouth jar using a clean stainless steel spoon or trowel.
10. Store samplers at 4 degrees (°) Celsius (C), $\pm 2^{\circ}\text{C}$. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.7.2 EnCore Sampler Equipment and Collection Requirements for High-Level Analyses (≥ 200 µg/kg)

The following equipment is required for high-level analysis:

- One 5-g sampler or one 25-g sampler (the sampler size used will be dependent on client and laboratory requirements)
- One 110-mL (4-oz.) wide-mouth glass jar or applicable container specified for moisture analysis
- One T-handle
- Paper towels

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The requirements for collecting high-level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sample and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
4. Use clean paper toweling to quickly wipe the sampler head so that the cap can be tightly attached.
5. Push cap on with a twisting motion to attach cap.
6. Fill out a sample label and attach to sampler.
7. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.
8. Collect moisture sample in 110-mL (4-oz.) wide-mouth jar or designated container using a clean stainless steel spoon or trowel.
9. Store samplers at 4°C, $\pm 2^\circ\text{C}$. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.2.7.3 Methanol Preservation Equipment and Sampling Requirements for High-Level Analyses ($\geq 200 \mu\text{g/kg}$)

The following equipment is required for methanol preservation sampling:

- One preweighed jar that contains methanol or a preweighed empty jar accompanied with a preweighed vial that contains methanol (laboratory grade)
- One dry weight cup
- Weighing balance that accurately weighs to 0.01 g (with accuracy of ± 0.1 g)
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

The requirements for sampling and preservation are as follows:

1. Wear clean gloves during all handling of preweighed vials.
2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.
3. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size used is dependent on client and laboratory requirements.
4. Carefully wipe the exterior of the collection device with a clean paper towel.
5. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.

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6. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
7. Using the paper toweling, remove any soil off of the vial threads and cap the jar.
8. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.
9. Collect dry weight sample using a clean stainless steel spoon or trowel.
10. Store samples at 4°, ±2°C.
11. Ship sample containers with plenty of ice in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

6.0 Restrictions/Limitations

Basket or spring retainers may be needed for split-barrel sampling in loose, sandy soils.

Shelby tubes may not retain the sample in loose, sandy soils.

7.0 References

American Society for Testing and Materials. 1999. *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*. Standard Method D1586-99.

_____. 2000. *Standard Test Method for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*. Standard Method D1587-00.

U. S. Department of Energy. 1996. Hazardous Waste Remedial Actions Program. *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2. September.

_____. Hazardous Waste Remedial Actions Program. *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1. September 1996 or current revision.

U. S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, June 1997). Method 5035 (**Note:** § 6.2.1.8 of this method says samples stored in EnCore™ samplers shall be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

_____. 2001. Region 4. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. November.

TSOP 1-5

GROUNDWATER SAMPLING USING BAILERS

Groundwater Sampling Using Bailers

SOP 1-5
Revision: 6
Date: March 2007

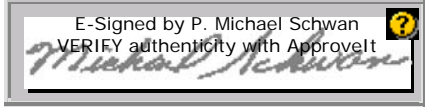
Prepared: Del Baird

Technical Review: Peggy Bloisa

QA Review: Jo Nell Mullins

Approved: 
Signature/Date

Issued:


Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define requirements for the collection of groundwater samples with bailers.

2.0 Background

Collection of groundwater samples from monitoring wells on or near a hazardous waste site may be required to characterize the nature and extent of contamination.

Methods used for the collection of groundwater samples include bailing and a variety of pumping techniques. Bailers are hollow cylinders with unidirectional (open up) check valves at the bottom end. Some bailers may also be closed or valved at the upper end. Bailers used in environmental applications are typically constructed of polyvinyl chloride (PVC), polyethylene, stainless steel, or Teflon[®]. Disposable polyethylene, PVC, and Teflon bailers are becoming more commonly used and eliminate the possibility of cross contamination as a result of poor decontamination. The bailer cable typically consists of disposable nylon cord, disposable polypropylene cord, or Teflon-coated stainless steel wire. The bailer is lowered into the well on an acceptable line until submerged. The bailer is then retrieved to the surface for sample collection. For the best results, the sequence of sampling is from least to most contaminated wells. It is preferable to have bailers dedicated to each monitoring well.

2.1 Associated Procedures

- CDM Federal (CDM) SOP 1-2, *Sample Custody*
- CDM SOP 1-6, *Water Level Measurement*
- CDM SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-3, *Well Development and Purging*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that groundwater samples are collected in accordance with this procedure.

Field Team Leader - The field team leader is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any associated SOPs.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers

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- Labels and appropriate forms/documentation for sample shipment
- Sample chain-of-custody forms
- Insulated cooler and waterproof sealing tape (strapping tape)
- Plastic zip-top bags
- Ice double-bagged in plastic zip-top bags
- Bailer of the appropriate design and construction for the sampling application
- Clean cord or wire of sufficient length for conditions
- Water level meter and/or other water level measuring device
- Clean beaker(s) or other container for measurement of water quality parameters
- Plastic sheeting (4-mil thickness)
- Latex or appropriate gloves
- Filtering apparatus, if required
- Appropriate sample containers with labels and preservatives, as required
- Temperature, conductivity, pH, dissolved oxygen, turbidity, and other meters as required by the site-specific field sampling plan
- Photoionization detector (PID) or equivalent and other instruments as required by the site-specific health and safety plan
- Decontamination supplies, as required by CDM SOP 4-5
- Personal protective clothing and equipment as required by the site-specific health and safety plan

5.0 Procedures

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan. All field equipment will be calibrated, tested, or checked for proper functioning before use per the manufacturer's instructions.
3. Prepare the site for sample acquisition. If required, cover the ground surface around the wellhead with plastic sheeting. Arrange the required decontaminated sampling and monitoring equipment for convenient use. If onsite decontamination is required, arrange the necessary supplies in a nearby but separate location, away from the wellhead (i.e., in an exclusion zone).
4. Open the well and note the condition of the casing and cap. Immediately check for organic vapors using a PID or flame ionization detector as appropriate. Refer to the site health and safety plan for the required monitoring and frequencies.
5. Determine the static water level and depth to well bottom in accordance with CDM SOP 1-6. Record this information in the field logbook or on the appropriate form.
6. Purge the well according to CDM SOP 4-3. Allow the water level in the well to recover to 75 percent of its static level so that a representative sample of the screened portion of the aquifer can be obtained. The bailer shall be completely submerged so that it does not contact the bottom of the well. Samples shall be collected within 3 hours of purging if recharge is sufficient. Wells with a low recharge rate must be collected within 24 hours of purging.
7. Securely attach the bailer to the line. The opposite end of the line shall be secured to prevent loss of the bailer into the well.
8. Arrange the sample containers in the order of use. Samples to be analyzed for volatile organic compounds (VOCs), if required, shall be obtained first, followed in order by other organic samples, then inorganic samples and other parameters. For example:

a) VOCs	e) Total organic carbon (TOC)	i) Cyanide
b) Purgeable organic carbon (POC)	f) Extractable organics*	j) Sulfate and chloride
c) Purgeable organic halogens (POX)	g) Total metals	k) Nitrate and ammonia
d) Total organic halogens (TOX)	h) Dissolved metals	l) Radionuclides

*Extractable organics include semivolatile organic compounds, pesticides, and PCBs.

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9. Don clean sampling gloves; lower the decontaminated or disposable bailer into the well. The bailer shall enter the water slowly to prevent aeration, particularly when VOC samples are being collected. Care shall be taken to avoid having the bailer come in contact with the well bottom.
10. Retrieve the filled bailer to the surface. To prevent contamination of the bailer line, do not allow line to contact the ground, rather keep line on the plastic sheeting. Hang the bailer from a bailer stand or other support, if available, or have an assistant hold it off the ground. Immediately obtain any required volatile samples (VOC, POC, POX, TOX, or TOC) by gently transferring water from the bailer to the sample bottle through a VOC sampling device inserted into the bottom of the bailer. Care shall be taken to adjust the flow of the water into the vial so that it is not too fast. The vial shall also be tilted so that the stream of water is directed down the side of the vial to reduce nonlaminar flow into the vial and to prevent aeration. Check the filled VOC vials for bubbles. If bubbles are present in a vial, discard it and fill another vial from the bailer. After collecting volatile samples, lower the bailer to collect additional water for the remaining parameters. If sample filtration is required for metals, it shall be performed immediately following sample retrieval, and before sample preservation. Organic samples generally do not require filtration; VOC samples shall never be filtered. Preservation of samples shall be performed according to the applicable field plan. Check the pH on samples (other than VOCs) that require preservation. Collect additional quality assurance/quality control samples (i.e., duplicate samples) as required by the applicable field plan.
11. Wipe the outer surfaces of the sample containers clean with a Kim-wipe or clean paper towel. Additional sample bottle decontamination may be appropriate in some cases.
12. Properly label all containers according to CDM SOP 2-1.
13. Place sample containers in individual zip-top plastic bags and seal the bags (if required by site-specific plans).
14. Immediately pack all sample containers that require a 4°C preservation on ice in coolers (refer to the site-specific field sampling plan).
15. Record analytes and volumes collected, and time and date of collection in the field logbook. Prepare chain-of-custody forms according to site-specific plans and CDM SOP 1-2.
16. Decontaminate sampling equipment as needed, according to CDM SOP 4-5.
17. Close and lock the well cover. Clean up the area and place disposable materials (plastic sheeting, gloves, Tyvek®) in the designated waste receptacle.
18. If required by the site-specific field sampling plan, obtain required field measurements such as temperature, conductivity, pH, oxidation potential (Eh), turbidity, salinity, or dissolved oxygen measurements immediately after samples have been collected and record them in the field logbook.

6.0 Restrictions/Limitations

Careful sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

Use of nondisposable bailers may contribute to cross contamination if proper and thorough decontamination procedures are not followed.

7.0 References

Office of Solid Waste and Emergency Response. 1992. *RCRA Ground-water Monitoring: Draft Technical Guidance*, EPA/530/R-93/001. November.

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TSOP 1-6
WATER LEVEL MEASUREMENT

Water Level Measurement

SOP 1-6
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Prepared: Del Baird

Technical Review: Peggy Bloisa

QA Review: Jo Nell Mullins

Approved: 

Issued: 
Signature/Date

Signature/Date

1.0 Objective

Water level measurements are fundamental to groundwater and solute transport studies and are conducted during groundwater sampling events to calculate the amount of groundwater to be purged from the well. This standard operating procedure (SOP) defines the techniques and requirements for obtaining groundwater level measurements.

2.0 Background

2.1 Definitions

Water Level Indicator - A portable device for measuring the depth from a fixed point (which could be below, at, or above the ground surface) to the groundwater inside a well, borehole, or other underground opening.

Measurement Point - An easily located and clearly defined mark at the top of a well from which all water level measurements from that particular well are made. The measurement point shall be as permanent as possible to provide consistency in measurements.

Electrical Tape - A graduated plastic tape onto which a water-sensitive electrode is connected that will electronically signal the presence of water (as a result of circuit closure).

Immiscible Fluids - Two or more fluid substances that will not mix and, therefore, will exist together in a layered form. The fluid with the highest density will exist as the bottom layer, the fluid with the lowest density will exist as the top layer, and any other fluid layers will be distributed relative to their respective densities.

Discharge - The removal/release of water from the zone of saturation.

Recharge - The addition of water to the zone of saturation.

Static Water Level - The level of water in a well, borehole, or other underground opening that is not influenced by discharge or recharge.

Well Riser - A steel, stainless steel, or polyvinyl chloride pipe that extends into a borehole and is connected to the well screen or sealed at the bedrock surface in open-hole wells. The upper portion (approximately 3 to 5 feet) of the well riser is normally enclosed by an outer steel protective casing.

Protective Casing - A steel cylinder or square protective sleeve extending approximately 3 to 5 feet into the ground, surrounding the well riser. In flush-mounted wells, the protective casing will extend only high enough so that the well and protective casing can be enclosed by a Christy box or equivalent vault. In above-grade wells, the protective casing will extend above the ground surface approximately 2 to 3 feet. The protective casing protects the well riser.

2.2 Associated Procedures

- CDM Federal (CDM) SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

The most common uses of static water level data are to determine the elevation of groundwater, the direction of groundwater flow, to identify areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relationships. Specific uses for water level data may include:

- Determine the change in water level due to distribution or rate of regional groundwater withdrawal
- Show the relationship of groundwater to surface water
- Estimate the amount, source, and area of recharge and discharge
- Determine rate and direction of groundwater movement

Static water level measurements shall be obtained from each well before purging, sampling, or other disturbance of the water table.

3.0 General Responsibilities

Project Manager - The project manager is responsible for ensuring that measurements are conducted in accordance with this procedure and any other SOP pertaining to site activities related to obtaining groundwater level measurements.

Field Team Leader - The field team leader is responsible for ensuring that field personnel obtain water level measurements in accordance with this and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens
- Permanent felt-tip marker (e.g., Sharpie)
- Personal protective equipment
- Decontamination equipment and supplies, including rinse bottles and deionized water
- Tap water and large beaker or bucket
- Water level meter

4.2 Measuring Devices

The equipment required to obtain water level measurements is dependent on the type of procedure chosen. Measurements may be made with a number of different devices and procedures. Measurements are taken relevant to a permanent measurement point on the well riser.

Electrical tapes are preferred over other devices such as steel tape because of the electrical tape's simplicity and ability to make measurements in a short period of time. Many types of electrical instruments have been devised for measuring water levels; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Examples of electrical tapes that are frequently used include the Slope Indicator Co.[®] and Solinst[®] electronic water level indicators. These instruments are powered by batteries that shall be checked before mobilization to the field.

Electrical tapes are coiled on a hand-cranked reel unit that contains the batteries and a signaling device that indicates when the circuit is closed (i.e., when the probe reaches the water). Electrodes are generally contained in a weighted probe that keeps the tape taut in addition to providing some shielding of the electrodes against false indications as the probe is being lowered into the hole. The electrical tapes are marked with 0.01-foot increments. Caution shall be exercised when using electrical tapes when the water contains elevated amounts of dissolved solids. Under these conditions, the signaling device will remain activated after the probe is removed from the water. When the water being measured contains very low amounts of dissolved solids, it is possible for the probe to extend several inches below the water level before activating the signaling device. Both of these conditions are related to the conductivity of the water and in some cases may be compensated for by the sensitivity control, if the device has this option. In groundwater with high conductivity the sensitivity control may need to be turned down, and in groundwater with low conductivity the sensitivity control may need to be turned up to get a proper depth to groundwater measurement.

5.0 Procedures

5.1 Preparation

The following steps must be taken when preparing to obtain a water level measurement:

- Assign a designated field logbook to record all field events and measurements according to CDM SOP 4-1. Document any and all deviations from SOPs and site-specific plans in the logbook and include rationale for the changes.
- Always exercise caution to prevent inappropriate or contaminated materials from entering an environmental well.
- Standing upwind from the well, open the groundwater well. Monitor the well with a photoionization detector, flame ionization detector, or equivalent vapor analyzer as soon as the cap is opened, as dictated by the site-specific health and safety plan.

For comparability, water level measurements shall always be referenced to the same vertical (elevation) datum marker, such as a U. S. Geological Survey (USGS) vertical and horizontal control point monument. The elevations calculated from the measurement of static water levels shall be referenced to mean sea level unless otherwise specified in the site-specific plans.

The measurement point must be as permanent as possible, clearly defined, marked, and easily located. Frequently, the top of the PVC riser is designated as the measurement point. However, since the top of the riser is seldom smooth and horizontal, one particular point on the riser pipe shall be designated and clearly marked. This can be accomplished by marking a point on the top of the riser pipe with a permanent marker. To avoid spilling liquids into the well, paints or other liquid marking materials shall not be used.

5.2 Water Level Measurement Using Electrical Water Level Indicators

The following steps must be followed when taking water level measurements using electrical tapes:

- Before lowering the probe into the well, the circuitry shall be checked by dipping the probe in tap water and checking to ensure that the signaling device responds to probe submergence. The probe shall then be lowered slowly into the well until contact with the water surface is indicated. The electrical tape reading is made at the measuring point. Take a second and third check reading to verify the measurement before completely withdrawing the tape from the well.
- Independent electrical tape measurements of static water levels using the tape shall agree within 0.01 foot for depths of less than about 200 feet. At greater depths, independent measurements may not be this close. For a depth of about 500 feet, the maximum difference of independent measurement using the same tape shall be within 0.1 foot.
- Decontaminate the electrical tape according to CDM SOP 4-5 before proceeding to the next well to minimize cross contamination.

It may be necessary to check the electrical tape length with a graduated steel tape after the line has been used for a long period of time (at least annually) or after it has been pulled hard in attempting to free the line. Some electrical tapes, especially the single line wire, are subject to becoming permanently stretched.

5.3 Other Water Level Measurement Methods

Although the method cited above (electrical water level indicator) for measuring water levels predominates in the environmental sector, there are a number of other methods available that may be well suited for a particular purpose.

5.3.1 Ultrasonic Method

The ultrasonic method electronically measures the amount of time it takes a sound wave to reach and reflect off the water surface and return to the ground surface. These instruments contain electronic microprocessors, capable of performing this measurement many times each second. The actual depth to water, as calculated by the microprocessor, is an average of many individual readings.

5.3.2 Pressure Gauge Method

This method, also called the air-line submergence method, uses a pressure gauge and is the preferred method for obtaining water level measurements in pumping wells. An air line constructed of semi-rigid tubing is inserted into the well below the water table. The tube end at the surface is connected to an air tank or compressor and pressure gauge. Filtered air is then forced through the tube and the resultant pressure is read in pounds per square inch (psi). This reading is converted to feet of water in the column and subtracted from the total tube length to give depth to water. Readings are then converted to groundwater elevation. Results are plotted on a field logging form. Calibration records and the exact procedures used must be maintained.

5.3.3 Acoustic Probe Method

The acoustic probe is an electronic device containing two electrodes and a battery-powered transducer. The probe is attached to a tape. The probe is lowered into the well until a sound is detected, indicating the electrodes in the probe have contacted the water surface. This method is similar to the electrical probe method discussed in Section 5.2.

5.3.4 Continuous Recording Method

The measurement of groundwater elevations within pumping or monitoring wells can be accomplished by the use of a mechanical or digital analog computerized continuous recording system and shall be performed according to specifications given by the manufacturer of each unit. In general, when using the mechanical or digital system, the pressure or electrical transducer is lowered into the well until it intersects the water surface. The actual depth to water is then measured by one of the methods described above and used to calibrate the continuous recorder.

The necessary adjustments and preparations are then completed according to the specifications given for each type of continuous recorder. Proper maintenance of continuous recording devices during water level monitoring shall be performed such that continuous, permanent records are developed for the specified period of time. Records shall be stored on mechanical graph paper or on a microprocessor. Frequent calibrations of equipment shall also be made during monitoring periods of long duration in accordance with the manufacturers' specifications.

6.0 Restrictions/Limitations

6.1 Groundwater and Miscible Fluids

Where water is rapidly dripping or flowing into a well, either from the top of the well or from fractures, obtaining an accurate reading may not be possible.

The effect of the water flowing into the well may interfere with an electronic water level measuring device, resulting in a false water level measurement. If water levels must be recorded in wells completed in aquifers that are recharging or discharging, the electronic water level indicator is the preferred measuring device, but shall be used with the awareness of possible false measurements. To minimize the effects of "splashing," a 1-inch pipe (decontaminated for environmental wells) may be lowered into the pumping well into which the water level indicator would be inserted. This will minimize the effect of "splashing" until the probe contacts the groundwater and protect the probe from becoming tangled in pump wiring or well spacers associated with downhole equipment such as submersible pumps.

6.2 Immiscible Fluids

For wells containing immiscible contaminants, the field personnel will need to use special procedures for the measurement of fluid levels. The procedure to follow will depend on whether layers are light immiscibles that form lenses floating on the top of the water table, or dense immiscibles that sink through the aquifer and form lenses over less permeable layers.

In the case of light immiscibles, measurements of immiscible fluid and water levels cannot be accomplished by using normal techniques. A conventional electrical tape often will not respond to nonconducting immiscible fluids.

Techniques have been specially developed to measure fluid levels in wells containing immiscible fluids, particularly petroleum products. A special paste or gel applied to the end of the steel tape and submerged in the well will show the top of the oil as a wet line and the top of the water as a distinct color change, or an interface probe can be used that will detect

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the presence of conducting and nonconducting fluids. Thus, if a well is contaminated with low density, nonconducting immiscible fluids such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction. However, when the probe is lowered deeper to contact water, it will detect electrical conduction. Normally, a variation in an audible signal indicates the difference between phases.

Both of these methods have disadvantages. These methods are less effective with heavier and less refined petroleum products because the product tends to stick to the tape or probe, giving a greater product thickness measurement than it shall. Paste or gel cannot be used when sampling groundwater for the same constituents present in the paste or gel product.

Note that water levels obtained in this situation are not suitable for determining hydraulic gradients without further interpretation. To use such data for determining hydraulic gradients, the difference in density between the light immiscible phase and water has to be considered.

Measuring fluid levels in wells screened in lenses of dense immiscible fluids resting on a low permeability formation is somewhat easier, provided the immiscible fluid is nonconducting. The top of the dense layer can be identified by simply using an electrical sounder. As an electrical sounder passes from groundwater into the immiscible phase, the detection unit will deactivate because the fluid will no longer conduct electricity. A better method would be to use an interface probe as described above. The variation in the audible signal associated with the detection of differing phase liquids will also allow the user to obtain a groundwater depth and dense immiscible thickness measurement.

7.0 References

Camp Dresser & McKee Inc., et al. 1991. *Sampling and Analysis Procedures, Geophysical Survey Procedures*. May.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001. December.

Weight, Willis D. and Sonderegger, John L., 2001. *Manual of Applied Hydrogeology*. Lewis Publishing Company. 187-190.

Westinghouse Savannah River Company. 1997. *Standard Operating Procedures Manual*, 3Q5, Chapter 13, Revision 2, Hydrogeologic Data Collection Procedures and Specifications. October.

TSOP 1-8

**Volatile Organic Compound Air Sampling
Using USEPA Method TO-15 With SUMMA[®] Canister**

Vapor Sampling Using a SUMMA[®] Canister

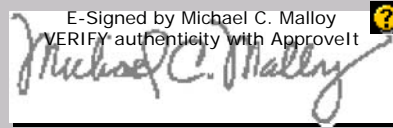
SOP 1-8
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Prepared: Del Baird/Chris Koerner

Technical Review: Chris Koerner

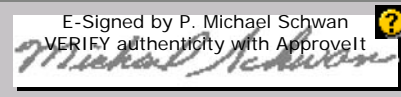
QA Review: Jo Nell Mullins

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E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt


Signature/Date

Issued:

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt


Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define requirements for collection of vapor using evacuated SUMMA[®] canister samplers.

2.0 Background

Collection of discrete or temporally composited air samples from designated locations on or near a hazardous waste site may be required to characterize and model the nature and extent of ambient or subsurface contamination. The method described in this SOP is adapted from U. S. Environmental Protection Agency Method TO-15 Second Edition 1999.

Two types of vapor samples can be collected with SUMMA canisters. The canister can be opened and allowed to fill over a short period to obtain a grab sample or filled slowly by using a flow controller to collect a time-integrated sample.

2.1 Definitions

Canister - Leak-free stainless steel pressure vessels of desired volume (e.g., 1 to 6 liters [L]), with valve and specially prepared (SUMMA) nonreactive interior surfaces. The canister is initially evacuated (under high vacuum) at the laboratory to approximately -30 inches of mercury (Hg). The canisters must be properly cleaned at the laboratory before each use by either ultra-pure humidified air in a series of evacuation/pressurization cycles or in a high temperature oven. The canister is then analyzed by GC/MS to verify cleanliness. **Note:** Canisters previously used for the measurement of high-level contamination may not be suitable for indoor air monitoring, since they may not be able to be adequately decontaminated.

Particulate Matter Filter - 2-micrometer (µm) sintered stainless steel in-line filter. A separate laboratory-cleaned filter is used for each canister sample.

Stainless Steel Vacuum/Pressure Gauges - A gauge capable of measuring vacuum (0 to -30 inches Hg or -100 to 0 kilo pascals [kPa]) and pressure (0 to 30 pounds per square inch [psi] or 0 to 206 kPa) is needed to verify the initial canister vacuum and to measure sampling progress in the sampling system. Gauges shall be tested clean and leak tight.

Sampling Inlet Line/Connectors - Stainless steel, Teflon[®], or polyethylene tubing (all usually ¼-inch diameter) and appropriate air-tight connectors (i.e., Swagelok[®] tube fittings) connect the canister to the sample inlet. A Swagelok fitting has four parts, the connector body, two ferrules, and the nut. The larger (cone-shaped) ferrule fits into the connector body, small diameter end first. The smaller end of the smaller ferrule fits on top of the cone ferrule, and the nut is screwed on top. The tubing fits through the nut and the two ferrules, and seats firmly in the connector. On newly created fittings, the nut shall be tightened with two wrenches, 1¼ turns past finger tight to compress the ferrules onto the tubing. (Swagelok makes an inspection gauge that fits between the nut and the connector body if a large number of critical connections are to be made). Connections that have been previously made up will only need a short tighten with the wrenches past finger tight.

Stainless Steel Shut-Off Valve - Leak free, for vacuum/pressure gauge.

Electronic Mass Flow Controller - This controller, used to collect composite samples, must be capable of maintaining a constant flow rate (±10 percent) over a sampling period of up to 24 hours and under conditions of changing temperature (20 to 40 degrees Celsius [°C]) and humidity.

Auxiliary Vacuum Pump - Continuously draws air through the inlet manifold at 10 L/minute or higher flow rate. The canister vacuum extracts a sample from the manifold at a lower flow rate, and excess air is exhausted. **Note:** The use of higher inlet flow rates dilutes any contamination present in the inlet and reduces the possibility of sample contamination as a result of contact with active adsorption sites on inlet walls. The auxiliary pump and sampling manifold can also be used to purge vapor monitoring wells.

Elapsed Time Meter/Stopwatch - Measures duration of sampling.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 1-10, *Field Measurement of Organic Vapors*

2.3 Discussion

Ambient air, emission source, or vapor monitoring well samples are collected to determine the type(s) and level(s) of contamination from airborne toxic organic compounds (often important to risk assessment), characterize subsurface vapor contamination, or evaluate vapor intrusion into buildings. These samples may be collected as part of an investigative plan, site-specific sampling plan, and/or as a screen for "hot spots," which may require more extensive sampling. Sampling will include necessary quality assurance/quality control (QA/QC) samples as documented in the project-specific QAPP, and a field blank shall accompany all sampled media.

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that SUMMA canister sampling efforts are performed consistently with this procedure and other project-specific documents such as the QAPP, work plan, sampling plan, and the health and safety plan.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect vapor samples in accordance with this or the project-specific procedure in the field plan and that appropriate documentation is collected.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment/Supplies

- Site-specific plans
- Adjustable wrenches (two 9/16-inch opened end wrenches for Swagelok fittings)
- Labels/canister tags (shall be attached to canister and appropriate laboratory-supplied, individual canister-specific, chain-of-custody forms)
- Field logbook or field forms
- Documentation for sample shipment
- Items listed in Section 2.1, Definitions, as applicable
- Sturdy shipping container(s)

5.0 Procedures

5.1 Preparation

1. The analysis of vapor samples collected in a canister will have very low detection limits. Canister preparation shall therefore be performed in clean air environments, away from any type of volatile organic contamination. The canisters are expensive, and, although relatively sturdy, valves and connections can be easily damaged. Do not over tighten valves. Use two wrenches to remove and reconnect line caps and attachments. Using a single wrench may cause excessive torque on the fitting/canister connection.
2. Check the number on the permanent label/tag attached to the canister against the laboratory-supplied chain-of-custody form. Verify that the canister number on the form agrees with the label. Note the date the canister was cleaned, preevacuated canister vacuum, and laboratory analysis verification, etc. The supplied paperwork will vary depending on the laboratory supplying the canister. The objective is to verify that the canister is the correct one, has been cleaned, and has been evacuated to a vacuum approximately -30" Hg.

3. In a clean environment, use two wrenches to remove the Swagelok cap from the end of the canister and attach a clean vacuum gauge. Verify that the gauge reads zero. Tighten the gauge fitting tightly with the wrenches. Open the canister valve, read the gauge, and record the reading on the chain-of-custody. SHUT THE VALVE TIGHTLY (turn clockwise). The vacuum reading shall agree closely (the field gauge may not be as accurate as the gauge in the laboratory) with the vacuum noted by the laboratory. If the field vacuum is more than 1 inch of Hg less than the laboratory vacuum, then the canister valve has leaked during the time since the canister was evacuated, and a portion of the canister has been filled with an unknown vapor sample. If the vacuum is not sufficient, replace the canister and document the change. If there are questions, call the laboratory that supplied the canister for guidance/to discuss further action.
4. If the two vacuum readings agree and the canister is suitable for use, verify that the valve is closed tightly, and remove the vacuum gauge. Attach a clean sample filter (supplied by the laboratory) and replace the Swagelok cap on the filter.
5. If required, build a sampling apparatus using appropriate tubing, connectors, or valves to connect the canister to the sampling location.
6. If a vacuum pump is to be used to purge a soil vapor monitoring well, insert a "tee" fitting between the well and the vacuum pump (upstream of the pump), and a line valve between the tee fitting and the pump. During purging, the line valve is opened and the third leg of the tee is capped, allowing the pump to pull air from the well without short-circuiting through the tee. If a portable photoionization detector, flame ionization detector, or other real-time instrument is to be used to take a field screening reading from the well, a second tee fitting shall be installed on the downstream side of the pump exhaust port. The probe of the instrument is inserted into one leg of the tee, while the other leg is allowed to vent, to prevent pressurizing the instrument and creating false readings.

5.2 Using a Flow Controller for Time-Integrated (Temporally Composited) Sampling

1. To ensure the correct time-integrated sampling rate, the flow controller must be calibrated for the planned sampling duration using a mass flow meter or bubble meter traceable to an American Society for Testing and Materials (ASTM) or National Institute of Standards and Technology (NIST) standard. This measurement will be made by actual calibration by the sampling team, or if calibrated by a laboratory, by checking calibration documentation.

A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled (to about 88.1 kPa for subatmospheric pressure sampling or to about 1 atmosphere above ambient pressure for pressurized sampling) over the desired sample period. The flow rate can be calculated by

$$F = \frac{P \times V}{T \times 60}$$

where:

F = flow rate, mL/minute

P = final canister pressure, atmospheres absolute. P is approximately equal to

$$\frac{\text{kPa gauge}}{101.2 \text{ kPa}} + 1$$

V = volume of the canister, mL

T = sample period, hours

For example, if a 6-L canister is to be filled to 202 kPa (2 atmospheres) absolute pressure in 24 hours, the flow rate can be calculated by:

$$F = \frac{2 \times 6,000}{24 \times 60} = 8.3 \text{ mL/minute}$$

2. The evacuated canister, flow controller (if required), vacuum gauge, particulate matter filter, and sample inlet need to be assembled (if not already pre-assembled by the offsite laboratory) using two open-end wrenches to tighten the tubing and sampling system components to the canister valve stem.

3. Data entries on the daily sample event data sheet (or equivalent) shall include serial numbers for all numbered sampling components, sample initiation time, sample identification number, sample collection time, separate entries for sub-atmospheric SUMMA canister pressures at sample initiation and completion, sampler initial(s), initiation date, collection date, and sample tag custody number.

5.3 Sample Collection

1. The sample system assembly is transported to the required sample location. Before collecting each sample, confirm that the canister number and sample identification corresponds to the correct sample location.
2. If using a vacuum pump to purge a vapor monitoring well or other space, begin preparing the canister when sufficient purging of the well has been accomplished. Attach a canister with the valve closed to the third leg of the tee upstream of the pump (discussed in 5.1), while the pump continues to pull vapor from the well. Do not connect the canister to the downstream side of the pump, since the pump may contain contaminants that may be introduced into the sample. The sample is drawn into the canister by the vacuum. When it is time to collect the sample, the valve between the canister and the pump is shut off, preventing backflow through the pump if the canister vacuum happens to be stronger than the pump.
3. When collecting a grab (not a temporally composited) sample, check the tightness of all fittings on the sampling apparatus and the connections on the canister. If sampling the ambient air or emission source, position the canister inlet in the intended environment with the inlet line pointed downward to prevent rainwater from entering the canister.
4. To initiate a sample event, gently open (counter clockwise) the canister valve until a hissing noise is heard. Note the initial vacuum reading on the gauge (attached to the canister with a tee) and that the vacuum level begins to drop. There are differing opinions on how long to allow for the canister to fill, and whether there is any negative effect of opening the valve rapidly. A good compromise is to adjust the valve so there is a slow hiss, allowing the canister to fill in about a half minute. The canister valve can be closed before the hissing stops and the vacuum gauge reaches 0 inches Hg. Record the final vacuum level on the chain-of-custody. Close the valve firmly, without overtightening.
5. Remove the canister from the sampling apparatus, remove the gauge and filter, and replace the canister cap. Do not use the same filter to collect another sample.
6. Record the final vacuum level, duration of sample collection, and any other pertinent sampling information of the chain-of-custody. Complete documentation on the daily event datasheet and the field logbook before leaving each sample location.
7. Place the canister in a sturdy container for shipping. Place all of the used filters in a plastic baggie and return them to the laboratory with the canisters.

6.0 Restrictions/Limitations

The nonreactive inner surface of the SUMMA canister may not be compatible for sampling atmospheres with high levels of chlorine or sulfur. Contact the analytical laboratory for guidance when these elements are suspected.

For 24-hour time-integrated sampling, sample flow rates through the vacuum gauge of the sample system may not remain stable (within the method flow rate tolerance) at vacuums less than 9 inches Hg (e.g., 8 inches Hg). Caution shall be taken in using 24-hour time-integrated samples where final vacuum is less than 4 inches Hg. Flow rates at this vacuum and below are not constant, yielding potentially nonrepresentative results during the latter portion of the sampling period. Any canister that has reached 0 inches Hg vacuum may not be a representative 24-hour sample.

Samples collected at vacuums above 10 inches Hg (e.g., when the canister valve is closed before the gauge reaches 10 inches Hg) may not contain enough sample volume to meet sample volume requirements for high-resolution gas chromatography/mass spectrometry analysis detection limits.

Ice crystals can block the flow controller or sampling apparatus at temperatures at or below freezing. Frequent monitoring of canister pressure is recommended during cold periods.

7.0 References

U. S. Environmental Protection Agency. 1999. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, Second Edition, *Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*. January.

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TSOP 1-9
TAP WATER SAMPLING

Tap Water Sampling

SOP 1-9
Revision: 4
Date: March 2007

Prepared: Tom Thornburgh

Technical Review: Scott Kirchner

QA Review: Jo Nell Mullins

Approved: 

Issued: 
Signature/Date

Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the requirements for collecting tap water samples for the purpose of assessing water quality. General guidelines for purging the water supply system before sample collection are also provided. Depending on the objective of the sampling event as defined in the site-specific sampling plan, the water source may be from a private or public potable water supply, such as a groundwater well or a surface water reservoir.

2.0 Background

2.1 Definitions

Holding Tank - An in-house water reservoir that provides a limited reserve water supply and equalizes water pressure throughout the plumbing system. Most domestic well holding tanks have a storage capacity of approximately 30 gallons.

Onsite Water Supply - A source of potable water located on the property to be sampled. The water source could be a groundwater aquifer (i.e., a residential groundwater well) or a surface water body (i.e., a water intake from a lake).

Potable Water - Water considered safe for human consumption.

Tap Water Samples - Samples of water collected from a faucet or spigot at a residence, business, or industrial plant. Usually, samples are collected from the tap(s) nearest the water supply source or area of interest along the distribution system.

Water Filter - A device used to remove suspended particulate matter and/or various compounds from the water source. One type of common filter is a water softener that uses a calcium-salt filter to remove calcium and magnesium ions from potable water to reduce the hardness.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-3, *Well Development and Purging*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

Tap water sampling may be conducted in residential, commercial, or industrial areas. Consequently, sampling personnel will interface with the general public (i.e., homeowners, business owners, or concerned citizens) and must present themselves in the utmost professional manner. Permission to access the property must be obtained before conducting the tap water sampling event; the client shall be consulted as to the proper notification procedures. At the time of the sampling, it is recommended that a letter of introduction be presented to the property owner or representative, explaining the purpose of the tap water sampling and indicating the name of the person and phone number to contact if the property owner has questions. At no time shall the sampling team enter a home or business without the approval of the property owner; the property owner or representative must be present to enter a building.

Generally, water supply sources and distribution systems can be categorized into two types:

- Onsite water supplies such as private, groundwater wells or surface water intakes for single residences, businesses, or industrial plants with limited distribution systems

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- Large distribution systems from public or municipal groundwater or surface water supplies with extensive distribution systems for multiple users

The site-specific sampling plan shall describe the source of the potable water supply, the water distribution system, and other site-specific factors that may affect the water quality (well construction details, local hydrogeology, the presence of filters or holding tanks within the distribution system, pipe age, and composition, etc.). It is preferable to collect the samples from a tap located prior to a filtering device or a holding tank so that contaminants will be less likely to have been removed or allowed to settle out. The sampling objectives and sampling requirements, including analytical parameters, preservatives, and sample handling procedures must also be specified. Depending on the water source and distribution system, the site-specific sampling plan shall describe the requirements for purging the system before collecting the tap water sample and for disposing of the purged water.

The procedures described in this SOP provide guidelines to obtain representative tap water samples from water supplies/distribution systems ranging from small onsite water supplies to large multiuser distribution systems.

3.0 General Responsibilities

Field Team Leader - The field team leader is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any associated SOPs.

Sampling Personnel - Field team members are responsible for conducting tap water sampling events in accordance with this procedure, all associated SOPs, and requirements as described in the site-specific plans.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

All or part of the equipment listed may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans including letter(s) of introduction
- Field logbook and indelible black ink pens and markers
- Forms and other documentation for sample shipment
- Sample containers, labels, and preservatives, as required
- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Plastic zip-top bags
- 5-gallon bucket and stopwatch
- Temperature, conductivity, pH, dissolved oxygen, and turbidity meters (with clean beakers or other appropriate containers), as required by the site-specific plans
- Photoionization detector (PID) and/or other monitoring/screening instruments as required by the site-specific health and safety plan or sampling plan
- Decontamination supplies, as required by SOP 4-5
- Personal protective equipment (PPE), as required by the site-specific health and safety plan
- Latex or appropriate gloves

5.0 Procedures

1. Obtain the name(s) of the resident(s) or water supply owner/operator, the exact mailing address, and telephone numbers. This information is required to obtain access to the property to be sampled and to submit a letter of introduction to the owner/representative.
2. Determine the location of the tap to be sampled based on its proximity to the water source. It is preferable that the tap being sampled be prior to any holding or pressure tanks, filters, water softeners, or other treatment devices that may be present.

Tap Water Sampling

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3. If the sample must be collected at a point in the water line beyond a pressurization or holding tank, a sufficient volume of water shall be purged to provide a complete exchange of fresh water into the tank and at the location where the sample is collected. If the sample is collected from a tap or spigot located just before a storage tank, spigots located inside the building or structure shall be turned on to prevent any backflow from the storage tank to the sample tap or spigot. It is generally advisable to open as many taps as possible during the purge, to ensure a rapid and complete exchange of water in the tanks.
4. Samples collected to determine if system related variables (e.g., transmission pipes, water coolers/heaters, holding/pressurization tanks) are contributing to the quality of potable water shall be collected after a specific time interval (e.g., weekend, holiday). Sample collection shall consist of an initial flush, a sample after several minutes, and another sample after the system has been purged.
5. Devices such as hoses, filters, or aerators attached to the tap may harbor a bacterial population and therefore shall be removed before sampling.
6. Sample containers shall not be rinsed before use when sampling for bacterial content, and precautions shall be taken to avoid splashing drops of water from the ground or sink into either the bottle or cap.
7. Samples of the raw water supply and the treated water after chlorination shall be collected when sampling at a water treatment plant.
8. In the logbook, record the location and describe the general condition of the tap selected for sampling. The rationale used in selecting the tap sampling location, including any discussions with the property owner, shall also be recorded. Provide a sketch of the water supply/distribution system noting the location of any filters or holding tanks and the water supply source (i.e., an onsite groundwater well or surface water intake or a water service line from a public water main). If an onsite water supply is present, observe and record the surrounding site features that may provide potential sources of contamination to the water supply.
9. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan. Latex gloves shall be changed between sampling locations to avoid possible cross contamination of the tap water samples.
10. Before sample collection, the supply system shall be purged by turning the cold water tap on. The following general guidelines shall be followed to determine when the system is adequately purged (refer to the site-specific sampling plans for any other requirements):
 - **Onsite Water Supply.** A minimum of three standing volumes of water (i.e., the static volume of water in the well and holding tank, if present) shall be purged. Obtain water temperature, conductivity, and pH measurements after each volume of water is purged. If the standing volume of water in the supply system is unknown, the tap shall be allowed to run for a minimum of 15 minutes and temperature, conductivity, and pH measurements, or other parameters as specified by the project plan, shall be collected at approximately 3- to 5-minute intervals. (In general, well construction details and holding tank volumes shall be obtained before conducting the sampling event to estimate the standing volume of the water supply system.) The system is considered adequately purged when the temperature, conductivity, and pH stabilize within 10 percent for three consecutive readings. If these parameters do not stabilize within 15 minutes, then purging shall be discontinued and tap water samples may be collected as discussed in Section 6.0.
 - **Large Distribution Systems.** Because it is impractical to purge the entire volume of standing water in a large distribution network, a tap shall be run for a minimum of 5 minutes, which shall be adequate to purge the water service line. Obtain temperature, conductivity, and pH measurements at approximately 1-minute intervals. The system is considered adequately purged when the temperature, conductivity, and pH readings, or other parameters as specified by the project plan, stabilize within 10 percent for three consecutive readings. If these parameters do not stabilize within 5 minutes, then purging shall be discontinued and tap water samples may be collected as discussed in Section 6.0.

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During purging, a 5-gallon bucket and stopwatch may be used to estimate the flow rate if required by the site-specific plans. Dispose of the purged water according to the site-specific plans. Record the temperature/conductivity/pH readings, or other parameters as specified by the project plan, the volume of water purged, the flow rate if measured, and the method of disposal in the field logbook.

11. After purging the supply system, collect the samples directly from the tap (i.e., if a hose was used for purging, the hose shall be disconnected before sampling). Any fittings on the end of the faucet that might introduce air into the sample (i.e., a fine mesh screen that is commonly screwed onto the faucet) shall be removed before sample collection also.
12. Obtain a smooth-flowing water stream at moderate pressure with no splashing. Samples for volatile organic compound (VOC) analyses shall be collected using a reduced flow rate (see below). Hold the sample bottle in one hand and the cap in the other; do not touch the inside of the cap; do not allow the faucet to touch the inside of the bottle; do not allow splashing water from the ground or sink to enter the bottle or cap. VOC samples shall be filled first, followed by other organic analyses, inorganic analyses, and then other water quality parameters. Refer to the site-specific plans for the required sample parameters, preservatives, and sample handling procedures. The following general guidelines shall be followed when collecting samples:
 - **VOC.** Reduce the flow rate to a minimum to reduce aeration of the VOC sample. Use a pre-preserved "test" vial to determine the appropriate amount of hydrochloric acid (HCl) needed to reduce the pH of the sample to less than 2. Dispose of this test vial after the appropriate amount of HCl is determined. Add the required amount of HCl to the sample vials and then fill the vials with the sample water. Quickly replace the cap and check for air bubbles. If air bubbles are present, the vial will be discarded and a new vial will be filled as detailed above.
 - **Semivolatile Organic Compounds (SVOCs), Pesticides, and Polychlorinated Biphenyls (PCBs).** Generally, aqueous samples for SVOCs and pesticides/PCBs require no preservative. Sample containers may be filled directly from the tap.
 - **Total (unfiltered) Metals.** Generally, tap water samples are not collected for filtered (dissolved) metals because risk assessment data needs require total metals analyses (check the site-specific plans to determine filtering requirements). The sample container for total metals may be filled directly from the tap. Nitric acid (HNO₃) shall then be added to the filled container to preserve the sample to a pH less than 2.
 - **Other Sample Parameters.** Other water quality parameters, such as cyanide dissolved oxygen, hardness, nitrate/nitrite, etc., shall be collected and preserved as required by the site-specific sampling plans.
13. Label all sample containers as required and place them in a cooler with ice. Record all appropriate data in the field logbook and on the chain-of-custody forms.

6.0 Restrictions/Limitations

To protect the sample from contamination on the exterior of a tap, a tap shall not be chosen for sampling if any of the following conditions exist:

- A leaky tap allowing water to flow out from around the stem of the valve handle and down the outside of the faucet.
- A tap located too close to the bottom of the sink or the ground surface.
- A tap that allows water to run up on the outside of the lip.
- A tap that does not deliver a steady stream of water. A temporary fluctuation in line pressure may cause sheets of microbial growth, lodged in some pipe sections or faucet connections, to break loose.

Careful sampling for VOC analysis, or for any other compound(s) that may be degraded by aeration, is necessary to minimize sample disturbance and, hence, analyte loss.

7.0 References

U. S. Environmental Protection Agency. Region IV. 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Section 8, Sampling of Potable Water Supplies. November.

TSOP 1-10

FIELD MEASUREMENT OF ORGANIC VAPORS

Field Measurement of Organic Vapors

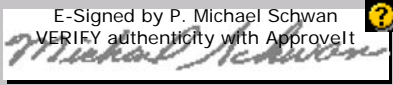
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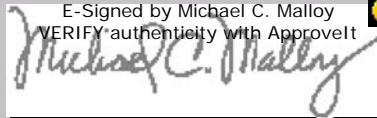
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Issued: _____

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1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and the requirements for the measurement of organic vapors in the field.

2.0 Background

2.1 Definitions

Photoionization Detector (PID) - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the photoionization of organic vapors.

Flame Ionization Detector (FID) - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the flame ionization of organic vapors.

2.2 Associated Procedures

- CDM Federal SOP 1-4, *Subsurface Soil Sampling*
- CDM Federal SOP 1-5, *Groundwater Sampling Using Bailers*
- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 1-8, *Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA Canister*
- CDM Federal SOP 3-1, *Geoprobe® Sampling*
- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-3, *Well Development and Purging*

2.3 Discussion

The measurement of organic vapors is a required step during numerous field activities. The primary purpose of such measurements is health and safety monitoring to determine if the breathing zone in a work area is acceptable or if personal protective equipment such as a respirator or a supplied air device is necessary for field personnel. In addition to health and safety monitoring, organic vapor measurement is also used in conjunction with sampling activities, including screening subsurface soil samples, soil vapor and indoor air sampling, and groundwater sampling, where measurements are useful for establishing approximate contaminant levels or ranges.

The two types of instruments most commonly used to measure organic vapors are PIDs and FIDs. Both instruments first ionize the gaseous compound and then measure the response, which is proportional to the concentration.

2.3.1 PID Operation

The PID is preferred when the compound of interest is an aromatic or chlorinated volatile organic compound (VOC). The PID ionizes the sampled vapors using an ultraviolet lamp that emits light energy at a specific electron voltage (eV - labeled on the lamp). The ultraviolet lamp produces photons that are absorbed by the sampled vapor molecule. The molecule becomes excited, producing a positively charged ion and emitting an electron. The number of electrons emitted is proportional to the concentration of the sampled gases. Every organic compound has a specific ionization potential in electron volts. The energy emitted by the lamp must be higher than the ionization potential of the compound for the compound to become ionized and emit an electron. If the ionization potential of the compound is higher than the eV of the lamp, there will be no response on the instrument. Therefore, the ionization potential of the known or suspected compounds shall be checked against the energy of the ultraviolet lamp to verify that the energy provided by the lamp is

greater. Additionally, manufacturer's manuals shall be consulted to obtain the appropriate correction factors for known or suspected contaminants.

Water vapor in the vapor sample can interfere with the PID detector and cause the instrument to stop responding. This can be caused by using the PID on a rainy day or when sampling headspace samples that have been in the sun. If

moisture is suspected, the calibration gas shall be used to check the instrument response by inserting the gas as a check sample, not by recalibrating. If the response is lower than the gas level, then the probe and the ionization chamber shall be dried out before reusing the instrument.

Note: The ultraviolet lamp in the PID is sensitive to shock, especially when using the higher eV lamps. Therefore, they shall be handled and transported carefully.

The sampling probe shall not be inserted directly into soil samples or dusty areas, as the instrument vacuum will pull dirt into the ionization chamber. Under particularly dirty or dusty conditions, the lamp may become covered with a layer of dust. If dirty conditions are encountered, or if the instrument response seems to have decreased, then the lamp shall be cleaned. The instrument manual provides instructions on how to remove the instrument cover to access the lamp, and how to clean the screen in the ionization chamber and the surface of the lamp.

2.3.2 FID Operation

The FID is preferred when sampling for petroleum hydrocarbons and methane (landfill gases). It responds well to aromatic hydrocarbons but is not as convenient to use as the PID. The FID allows measurement of a wide variety of compounds, but in general its sensitivity is not as high as the PID for compounds where the PID is applicable.

The FID ionizes the vapor sample by burning it in a hydrogen/air flame, and measuring the response beyond what is caused by the hydrogen alone. This instrument requires a hydrogen supply, contained in a small tank in the instrument. This hydrogen, including the gas in the instrument tank, is considered a flammable gas and appropriate requirements must be adhered to when shipping. The instrument shall be emptied of hydrogen before shipping. Federal Express Hazardous Material shipping manifests must be completed when shipping the gas.

The hydrogen gas in the FID combustion chamber is ignited by pressing a red button on the side of the instrument, which sends electrical current to a small resistance coil igniter in the combustion chamber. This igniter is very sensitive, and if the red button is pressed for longer than 5 seconds, the coil will burn out and the instrument will be unusable unless another igniter is available. If the instrument will not light, check the electrical connections and switches for proper settings. Check that the pump is pumping, and allow fresh air to flow through the combustion chamber for several minutes before lighting. Check to see if the exhaust port of the combustion chamber is dirty.

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field activities are conducted in accordance with this procedure and any other SOPs pertaining to the specific activity.

Field Team Leader - The field team leader is responsible for ensuring that field personnel conduct field activities in accordance with this and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Site-specific plans
- Field logbook
- Waterproof black ink pen
- Personal protective clothing and equipment
- Photoionization detector or flame ionization detector
- Calibration gases in a range appropriate for the expected use
- 0.5 liter (16-ounce) or "Mason" type glass jar
- Hydrogen Canister and fill valve and hose (if using FID for a period of more than 1 day)

5.0 Procedures

5.1 Direct Reading Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.
2. Calibrate the instrument following the applicable manufacturer's manual
3. Make sure the instrument is reading zero and all function and range switches are set appropriately.
4. Insert the end of the probe directly into the atmosphere to be measured (e.g., breathing zone, monitoring well casing, split spoon, etc.) and read the organic vapor concentration in parts per million (ppm) from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.
5. Immediately document the reading in the field logbook or on the appropriate field form.

5.2 Headspace Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.
2. Calibrate the instrument following the appropriate manufacturer's manual.
3. Make sure the instrument is reading zero and all function and range switches are set appropriately.
4. Fill a clean glass jar approximately half-full of the sample to be measured. Quickly cover the top of the jar with one or two sheets of clean aluminum foil and apply cap to seal the jar.
5. Allow headspace to develop for approximately 10 minutes. It is generally preferable to shake the sealed jar for 10 to 15 seconds at the beginning and end of headspace development.

Note: When the ambient temperature is below 0°C (32°F), the headspace development and subsequent measurement shall occur within a heated vehicle or building.

6. Remove the jar cap and quickly puncture the foil and insert the instrument probe to a point approximately one-half of the headspace depth. Do not let the probe contact the soil. If using a PID and there is condensation on the inside of the jar, only leave the probe in the jar long enough to obtain a reading. Remove the probe and allow fresh air to flow through the instrument to avoid excess water vapor to build up.
7. Read the organic vapor concentration in ppm from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.
8. Immediately record the reading in the field logbook or on the appropriate field form.

6.0 Restrictions/Limitations

The two methods outlined above are the most commonly used for field measurement of organic vapors but do not apply to all circumstances. Consult project- or program-specific procedures and guidelines for deviations. Both the PID and FID provide quantitative measurement of organic vapors, but generally neither instrument is compound-specific. The typical reading range of the PID is 0 to 2,000 ppm, and the typical reading range of the FID is 0 to 1,000 ppm. The FID will measure methane while the PID will not. **Note:** The presence of methane will cause erratic PID measurements. In methane rich environments, toxic organic vapors shall be monitored with an FID. If desired, a charcoal filter can be placed temporarily on the FID inlet probe, which will trap all organic vapors except methane. The filtered (methane only) reading can be subtracted from unfiltered (total organic vapors) to provide an estimate of non-methane organic vapors. The reading accuracy of both instruments can be affected by ambient temperature, barometric pressure, humidity, lithology, etc.

7.0 References

Martin Marietta Energy Systems, Inc. 1998. *Environmental Surveillance Procedures Quality Control Program*, ESH/Sub/87-21706/1.

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SEDIMENT/SLUDGE SAMPLING

Sediment/Sludge Sampling

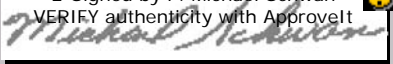
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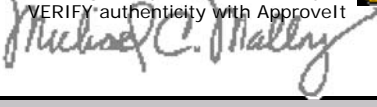
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Issued: _____
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1.0 Objective

The purpose of this standard operating procedure (SOP) is to define requirements for collection and containment of sediment/sludge samples.

2.0 Background

2.1 Definitions

Sediment - Geologic and/or organic material underlying a body of water. The material has been transported by a fluid and deposited within the boundaries of the body of water.

Sludge - Materials ranging in type from dewatered solids to high viscosity liquids. The material may exist suspended throughout the water or settled from the water as all or part of the sediment.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Composite - Two or more subsamples taken from a specific media and site at a specific point in time. The subsamples are collected and mixed, then a single average sample is taken from the mixture.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-2, *Photographic Documentation of Field Activities*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.2 Discussion

Sediment/sludge samples are collected to determine the type(s) and level(s) of contamination in a particular surface water body and/or its biological disposition. Sediment/sludge samples will provide a more historical account of contamination than will water samples because of the nature of the matrix.

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this and related SOPs and the required equipment.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The FTL must also ensure that the quantity and location of sediment/sludge samples collected meet the requirements of the site-specific plans.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

All or part of the equipment listed under the "as needed" category may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or "blue ice"
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment
- Latex or appropriate gloves
- Rubber boots and/or rubberized waders
- Stainless steel or Teflon® spoons, spatulas, or scoops
- Teflon or stainless steel mixing bowls or trays
- Aluminum foil
- Kimwipe or paper towels
- ½- to ¾-inch (12- to 19-mm) braided nylon line or Teflon-coated wire rope
- Clean plastic sheeting
- Tap and deionized water
- Water spray bottle
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies
- Eckman grab for depositional area (primarily stream) sediment sampling
- Ponar sampler for lake sampling

As needed:

- Global Positioning System (GPS) unit
- Hand or gravity corer with extensions or stainless steel hand auger
- Core liners of Teflon, stainless steel, brass, aluminum, or polybutyrate, as specified in the site-specific plan(s)
- Stainless steel push tubes
- Dredge with 15- to 20-foot (4.5- to 6.0-meter) sampling pole (hollow) and insert (e.g., Peterson, Eckman, Ponar)
- Motorized coring device
- Boat with depth finder for deep water or inaccessible shorelines
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment
- Tape measure

5.0 Procedures

5.1 Preparation

The following steps shall be taken when preparing for sampling sediment/sludge:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.
3. Select stream/river sampling locations that exhibit cross-sectional homogeneity. Avoid areas where the channel is constricted or bends where scouring may have occurred. For lakes, collect sediment samples away from the shoreline.
4. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.
5. If surface water is present at the sample location, make field measurements in physical, chemical, and biological characteristics of the water (e.g., temperature, dissolved oxygen, conductivity, pH), as dictated by the project-specific plans.
6. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in 1 day, always collect from downstream to upstream.
7. When sampling sediment and surface water from the same surface water body, collect surface water samples before sediment samples.

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8. Document the sampling events, recording all information in the designated field logbook and take photographs (if required). Document any and all deviations from this SOP and include rationale for changes.
9. The collection points shall be located on a site map and described in the field logbook. Use GPS if required or if possible.
10. Label each sample container with the appropriate information. Secure the label by covering it with a piece of waterproof clear tape.
11. Decontaminate reusable sampling equipment after sample collection according to CDM Federal SOP 4 5.
12. Processes for verifying depth of samples must be included in site-specific project plans.
13. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Sediment/Sludge Sample Collection from Shallow Waters

5.2.1 Method for Collecting Samples for Volatile Organic Compound (VOC) Analysis

The following steps must be followed when collecting shallow water sediment/sludge VOC samples:

1. Use a decontaminated stainless steel or Teflon, long-handled scoop, corer, push tube, or dredge to collect the entire sample in one grab. If wading is necessary, approach the sample location from downstream. Do not enter the actual sample area.
2. Retrieve the sampling device and slowly decant off any liquid phase.
3. Immediately fill the specified sample container(s) with the solid. Use a clean stainless steel or Teflon spoon or spatula to completely fill the container(s), ensuring no headspace.

Note: Samples to be analyzed for VOC or other compounds degraded by aeration shall be taken as grab samples. Do not homogenize or composite these samples.

4. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of the container clean with a Kimwipe or clean paper towel. Affix a completed sample label.
5. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
6. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Samples for Nonvolatile Organic and Inorganic Compound Analysis

The following steps must be taken when collecting shallow water sediment/sludge samples for analytes not degraded by aeration:

1. Collect sufficient volume to fill specified sample containers using decontaminated stainless steel or Teflon-lined equipment (scoops, corer, dredge sampler, etc.). If wading is necessary, approach the sample location from downstream. Do not enter the actual sample area.
2. Retrieve the sampling device with the sample and slowly decant off any liquid phase.
3. Pool and homogenize samples in a stainless steel, Teflon, or appropriate pan or mixing bowl, using stainless steel spatula or spoon.
4. Fill each sample container with the homogenized sample to approximately 75 to 90 percent capacity, filling sample containers for organics analyses first.

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5. Once each container is filled, close the container with a Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
6. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
7. Immediately pack all samples into a chilled cooler.

5.3 Subsurface Sediment/Sludge Sample Collection Using a Corer or Auger from Shallow Waters

5.3.1 Method for Collecting Samples for Volatile Organic Compound Analysis Using an Unlined Corer (also applies to augers)

The following steps must be taken when collecting subsurface sediment/sludge VOC samples that underlie shallow water:

1. At the specified sampling location, force or drive the corer to the specified depth.
2. Twist and withdraw the corer in a smooth motion.
3. Retrieve the sampling device, remove the corer nosepiece (if possible), and extrude the sample into the specified sampling container(s). Use a clean stainless steel or Teflon spoon or spatula to completely fill the container(s), ensuring no headspace.
4. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of the sample container clean with a Kimwipe or clean paper towel. Affix a completed sample label.
5. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
6. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Collecting Samples for Volatile Organic Compound Analysis Using a Lined Corer

The following steps must be followed when collecting shallow water subsurface sediment/sludge VOC samples that underlie shallow water:

1. Install decontaminated liner(s) in the corer barrel.
2. At the specified sampling location, force or drive the corer to the specified depth.
3. Twist and withdraw the corer in a smooth motion.
4. Retrieve the sampling device, remove the corer nosepiece (if possible) and remove the liner(s), cap the liner(s), and seal the caps with Teflon tape.
5. Wipe the outside of the liner clean with a Kimwipe or clean paper towel. Label the top and bottom ends of the liner(s). Affix a completed sample label.
6. Place capped and sealed liners in individual zip-top plastic bags and seal the bags.
7. Immediately pack all samples into a chilled cooler.

5.3.3 Method for Collecting Samples for Nonvolatile Organic and Inorganic Compound Analysis Using a Corer (also applies to augers)

The following steps must be followed when collecting subsurface sediment/sludge samples that underlie shallow water for analytes not degraded by aeration:

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1. At the specified sampling location, force or drive the corer to the specified depth.
2. Twist and withdraw the corer in a smooth motion.
3. Retrieve the sampling device. Remove the corer nosepiece (if possible) and extrude the sample into a stainless steel or Teflon-lined pan or bowl. Collect sufficient sample volume to fill all containers.
4. Use a stainless steel or Teflon spoon or spatula to homogenize and then divide the sample material into the appropriate number of sample containers.
5. Fill each container to approximately 75 to 90 percent capacity, filling containers for organics analyses first. Close the container with a Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
6. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
7. Immediately pack all samples into a chilled cooler.

5.4 Sediment/Sludge Sample Collection Using a Dredge from Deep Waters

5.4.1 Method for Collecting Samples for Volatile Organic Compound Analysis

The following steps must be followed when collecting deep-water sediment/sludge VOC samples:

1. Attach a clean piece of ½- to ¾-inch (12- to 19-mm) braided nylon line or Teflon-coated wire rope to the top of the sampler. The line must be of sufficient length to reach the sediment or sludge and have enough slack to release the mechanism. Mark the distance to the bottom on the line.
2. Attach the free end of the sampling line to a fixed support to prevent loss of the sampler.
3. At the specified sampling location, open the sampler jaws and slowly lower the sampler until contact with the bottom (sediment/sludge) is felt.
4. Release tension on the line; allow sufficient slack for the mechanism (latch) to release. Slowly raise the sampler.
5. Once the sampler is above the water surface, place the sampler in a stainless steel or Teflon-lined tray or pan. Open the sampler. Immediately collect the sample for VOC analysis, using a stainless steel or Teflon spoon or spatula. Fill each container completely to minimize headspace.
6. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
7. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
8. Immediately pack all samples into a chilled cooler.

5.4.2 Method for Collecting Samples for Nonvolatile Organic and Inorganic Compounds

The following steps must be followed when collecting deep-water sediment/sludge samples for analytes not degraded by aeration:

1. Attach a clean piece of ½- to ¾-inch (12- to 19-mm) braided nylon line or Teflon-coated wire rope to the top of the sampler. The line must be of sufficient length to reach sediment or sludge and have enough slack to release the mechanism. Mark the distance to the bottom on the line.

TSOP 2-1

PACKAGING AND SHIPPING OF ENVIRONMENTAL SAMPLES

Packaging and Shipping Environmental Samples

SOP 2-1

Revision: 3

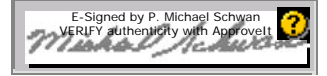
Date: March 2007

Prepared: Krista Lippoldt

Technical Review: Chuck Myers

QA Review: Jo Nell Mullins

Approved: 

Issued: 
Signature/Date

Signature/Date

1.0 Objective

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples. Additionally, Sections 2.0 through 7.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and applies only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data loggers and self-contained breathing apparatus [SCBAs] or bulk chemicals that are regulated under the DOT, IATA, and ICAO.

1.1 Packaging and Shipping of All Samples

This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

- Section 2.0 - Packaging and Shipping Samples Preserved with Methanol
- Section 3.0 - Packaging and Shipping Samples Preserved with Sodium Hydroxide
- Section 4.0 - Packaging and Shipping Samples Preserved with Hydrochloric Acid
- Section 5.0 - Packaging and Shipping Samples Preserved with Nitric Acid
- Section 6.0 - Packaging and Shipping Samples Preserved with Sulfuric Acid
- Section 7.0 - Packaging and Shipping Limited-Quantity Radioactive Samples

1.2 Background

1.2.1 Definitions

Environmental Sample - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal - A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

Inside Container - The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

Outside Container - The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

Secondary Containment - The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

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Excepted Quantity - Excepted quantities are limits to the mass or volume of a hazardous material in the inside and outside containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Limited Quantity - Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance Testing - Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper - A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*

1.2.3 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples shall be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

1.3 Required Equipment

- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

*Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.
2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.
3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).
4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. **Note:** Trip blanks must be included in coolers containing VOA samples.

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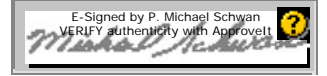
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- Section 6.0 - Packaging and Shipping Samples Preserved with Sulfuric Acid
- Section 7.0 - Packaging and Shipping Limited-Quantity Radioactive Samples

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Environmental Sample - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal - A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

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Outside Container - The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

Secondary Containment - The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

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1.2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*

1.2.3 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples shall be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

1.3 Required Equipment

- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

*Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.
2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.
3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).
4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. **Note:** Trip blanks must be included in coolers containing VOA samples.

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1.3 Required Equipment

- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- "This End Up" and directional arrow labels

*Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.
2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.
3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).
4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. **Note:** Trip blanks must be included in coolers containing VOA samples.

Appendix B
Shipment Quality Assurance Checklist

Date: _____ Shipper: _____ Destination: _____

Item(s) Description: _____

Radionuclide(s): _____

Radiological Survey Results: surface _____ mrem/hr 1 meter _____

Instrument Used: Mfgr: _____ Model: _____

S/N: _____ Cal Date: _____

Limited-Quantity or Instrument and Article

- | Yes | No | |
|------------|-----------|---|
| _____ | _____ | 1. Strong tight package (package that will not leak material during conditions normally incidental to transportation). |
| _____ | _____ | 2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr. |
| _____ | _____ | 3. Removable surface contamination less than 20 dpm/100 cm ² (alpha) and 1,000 dpm/100 cm ² (beta/gamma). |
| _____ | _____ | 4. Outside inner package bears the marking "Radioactive." |
| _____ | _____ | 5. Package contains less than 15 grams of ²³⁵ U (check yes if ²³⁵ U not present). |
| _____ | _____ | 6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910." |
| _____ | _____ | 7. Activity less than that specified in 49 CFR 173.425. Permissible package limit:
Package Quantity: |
| _____ | _____ | 8. On all air shipments, the statement Radioactive Material, excepted package-limited quantity of material shall be noted on the air waybill. |

Qualified Shipper: _____ Signature: _____

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5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally.
6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record. The chain-of-custody with the cooler shall reflect only those samples within the cooler.
7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) if the analytical method requires cooling. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.
8. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.
9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals shall be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.
10. The shipping container lid must be marked **"THIS END UP"** and arrow labels that indicate the proper upward position of the container shall be affixed to the cooler. A label containing the name and address of the shipper (CDM) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

2.0 Packaging and Shipping Samples Preserved with Methanol

2.1 Containers

- The maximum volume of methanol in a sample container is limited to 30 ml.
- The sample container must not be full of methanol.

2.2 Responsibility

It is the responsibility of the qualified shipper to:

- Ensure that the samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

2.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packing may consist of glass or plastic jars
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

2.4 Packaging Samples Preserved with Methanol

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
 - Project name
 - Project number
 - Date and time of sample collection
 - Sample location
 - Sample identification number
 - Collector's initials
 - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Total volume of methanol per shipping container must not exceed 500 ml.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Methanol Mixture
UN1230
LTD. QTY.

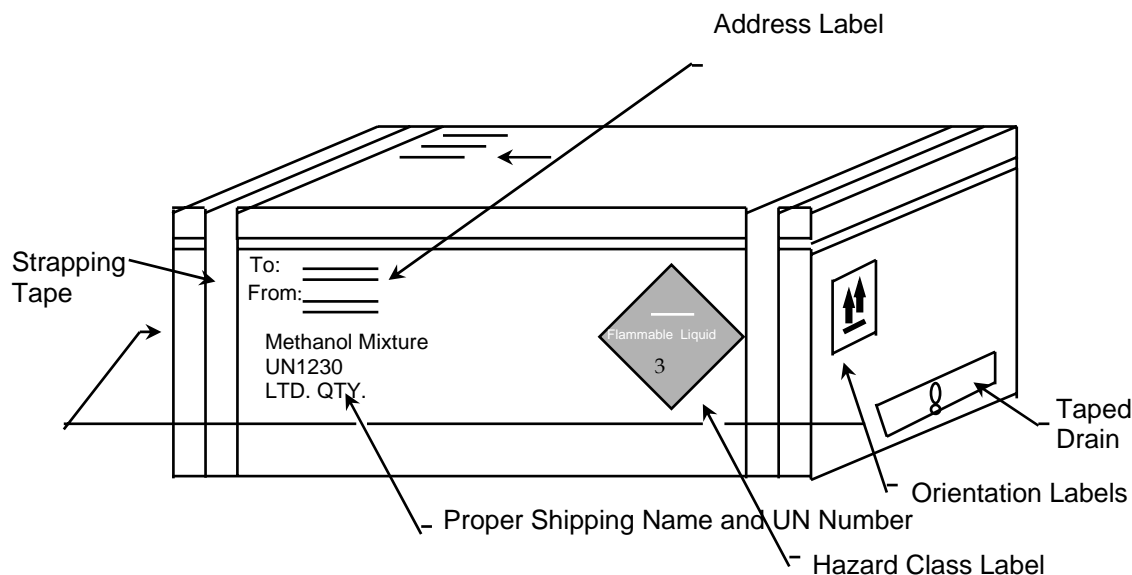
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marketing locations is shown in Figure 1.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

Figure 1
Example of Cooler Label/Marking Locations



3.0 Packaging and Shipping Samples Preserved with Sodium Hydroxide

3.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sodium Hydroxide Preservatives

<i>Preservative</i>		<i>Desired in Final Sample</i>		<i>Quantity of Preservative (ml) for Specified Container</i>				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.2 Responsibility

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

3.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Inner packings may consist of glass or plastic jars no larger than 1 pint
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

3.4 Packaging Samples Preserved with Sodium Hydroxide

Samples containing NaOH as a preservative that exceed the excepted concentration of 0.08 percent (2 ml of a 30 percent NaOH solution per liter) may be shipped as a limited quantity per packing instruction Y819 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
 - Project name
 - Project number
 - Date and time of sample collection
 - Sample location
 - Sample identification number
 - Collector's initials
 - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- The total volume of sample in each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Sodium Hydroxide Solution
UN1824
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marketing locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.08 percent NaOH by weight may be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

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- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

4.0 Packaging and Shipping Samples Preserved with Hydrochloric Acid

4.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Hydrochloric Acid Preservatives

<i>Preservative</i>		<i>Desired in Final Sample</i>		<i>Quantity of Preservative (ml) for Specified Container</i>		
		pH	Conc.	40 ml	125 ml	250 ml
HCl	2N	<1.96	0.04%	.2	.5	1

5 drops = 1 ml

4.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packing may consist of glass or plastic jars no larger than 1 pint.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

4.4 Packaging Samples Preserved with Hydrochloric Acid

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
 - Project name
 - Project number
 - Date and time of sample collection
 - Sample location
 - Sample identification number
 - Collector's initials
 - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (No more than 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)

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- Total volume of sample inside each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Hydrochloric Acid Solution

UN1789

LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marketing locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.04 percent HCl by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

5.0 Packaging and Shipping Samples Preserved with Nitric Acid

5.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Nitric Acid Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HNO ₃	6N	<1.62	0.15%		2	4	5	8

5 drops = 1 mg/L

5.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

5.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

5.4 Packaging Samples Preserved with Nitric Acid

Samples containing HNO_3 as a preservative that exceed the excepted concentration of 0.15 percent HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity sample shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
 - Project name
 - Project number
 - Date and time of sample collection
 - Sample location
 - Sample identification number
 - Collector's initials
 - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

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Nitric Acid Solution (with less than 20 percent)

UN2031

Ltd. Qty.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marketing locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.15 percent HNO_3 by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

6.0 Packaging and Shipping Samples Preserved with Sulfuric Acid

6.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sulfuric Acid Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
H_2SO_4	37N	<1.15	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

6.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

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- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

6.4 Packaging of Samples Preserved with Sulfuric Acid

Samples containing H_2SO_4 as a preservative that exceed the excepted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
 - Project name
 - Project number
 - Date and time of sample collection
 - Sample location
 - Sample identification number
 - Collector's initials
 - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Sulfuric Acid Solution
UN2796
LTD. QTY.

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marketing locations is shown in Figure 1.

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Note: Samples containing less than the exception concentration of 0.35 percent H_2SO_4 by weight will be shipped as nonregulated or nonhazardous in accordance with the procedure described in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

7.0 Packaging and Shipping Limited-Quantity Radioactive Samples

7.1 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

7.2 Description/Responsibilities

- The qualified shipper will determine that the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, *Limited Quantities of Radioactive Materials*.
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.
- If the shipment is from a DOE facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring before shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM will apply the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm^2 (alpha) and 1,000 dpm/100 cm^2 (beta/gamma). It shall be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive."
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

7.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Excepted quantities label
- Consignor/consignee labels

7.4 Packaging of Limited-Quantity Radioactive Samples

The following steps are to be followed when packaging limited-quantity sample shipments:

- The cooler is to be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape before sampling.
- At a minimum the label must contain:
 - Project name
 - Project number
 - Date and time of sample collection
 - Sample location
 - Sample identification number
 - Collector's initials
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tying or taping.
- Place a label marked Radioactive on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: ***"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."***
- Note that both DOT and IATA apply different limits to the quantity in the inside packing and in the outside packing.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of the cooler labeling/markings is shown in Figure 2.

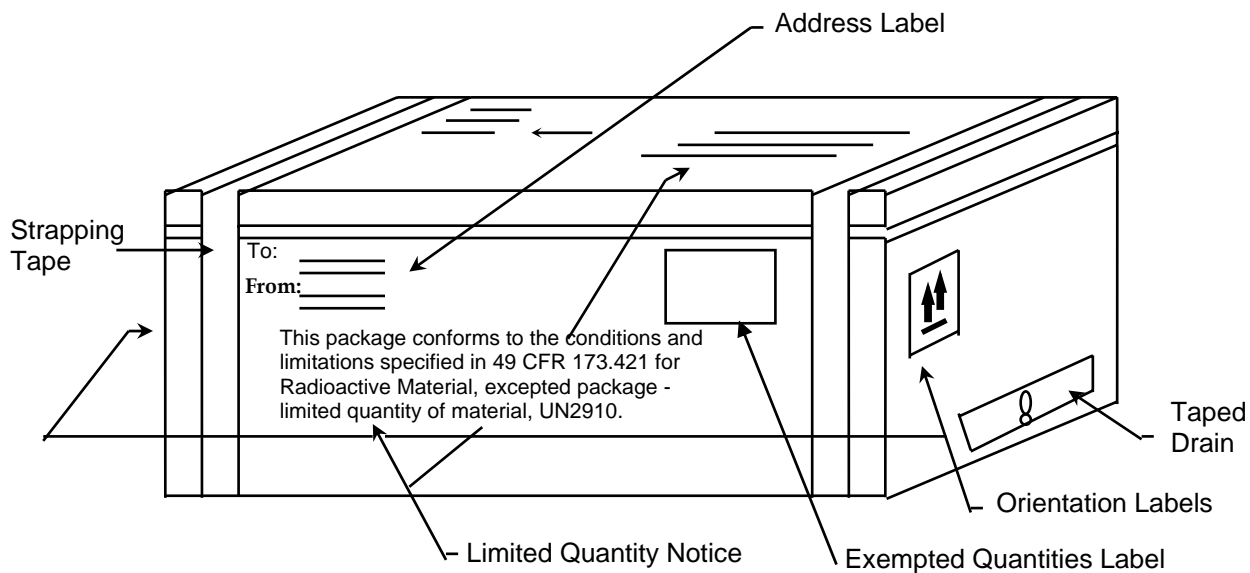
Note: No marking or labeling can be obscured by strapping or duct tape.

- Complete the Shipment Quality Assurance Checklist (Appendix B).

Note: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U .

Note: A declaration of dangerous goods is not required.

Figure 2
Radioactive Material – Limited-Quantity Cooler Marking Example



8.0 References

U. S. Environmental Protection Agency. Region IV. February 1991 or current. *Standard Operating Procedures and Quality Assurance Manual*.

_____. 1996 or current. *Sampler's Guide to the Contract Laboratory Program*, EPA/540/R-96/032.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous, Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

Title 49 Code of Federal Regulations, Department of Transportation. 2005 or current revision. *Shippers General Requirements for Shipments and Packagings*, 49 CFR 173.

Appendix A Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity

Sample Packaging

Yes	No	N/A	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The VOA vials are wrapped in bubble wrap and placed inside a zip-type bag.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The VOA vials are placed into a polyethylene bottle, filled with vermiculite, and tightly sealed.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The drain plug is taped inside and outside to ensure control of interior contents.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The cooler weighs less than the 66-pound limit for limited-quantity shipment.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The garbage bag has been sealed with tape (or tied) to prevent movement during shipment.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The chain-of-custody has been secured to the interior of the cooler lid.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The cooler lid and sides have been taped to ensure a seal.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape.

Air Waybill Completion

Yes	No	N/A	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 1 has the shipper's name, company, and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 2 has the recipient's name and company along with a telephone number where they can be reached.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 3 has the Bill Sender box checked.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 4 has the Standard Overnight box checked.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 5 has the Deliver Weekday box checked.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Under the Transport Details box, the Cargo Aircraft Only box is obliterated, leaving only the Passenger and Cargo Aircraft box.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Under the Shipment Type , the Radioactive box is obliterated, leaving only the Non-Radioactive box.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Under the Nature and Quantity of Dangerous Goods box, the Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions, and Authorization have been filled out for the type of chemical being sent.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The Name, Place and Date, Signature, and Emergency Telephone Number appears at the bottom of the FedEx Airbill.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The statement "In accordance with IATA/ICAO" appears in the Additional Handling Information box.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The Emergency Contact Information at the bottom of the FedEx Airbill is truly someone who can respond any time of the day or night.

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<i>Proper Shipping Name</i>	<i>Class or Division</i>	<i>UN or ID No.</i>	<i>Packing Group</i>	<i>Sub Risk</i>	<i>Quantity</i>	<i>Packing Instruction</i>	<i>Authorization</i>
Hydrochloric Acid Solution	8	UN1789	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Nitric Acid Solution (with less than 20%)	8	UN2031	II		1 plastic box × 0.5 L	Y807	Ltd. Qty.
Sodium Hydroxide Solution	8	UN1824	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Sulfuric Acid Solution	8	UN2796	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Methanol	3	UN1230	II		1 plastic box × 1 L	Y305	Ltd. Qty.

Sample Cooler Labeling

Yes No N/A

- | | | | |
|--------------------------|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The proper shipping name, UN number, and Ltd. Qty. appears on the shipping container. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The name and address of the shipper and receiver appear on the top and side of the shipping container. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The air waybill is attached to the top of the shipping container. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Up Arrows have been attached to opposite sides of the shipping container. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Packaging tape does not obscure markings or labeling. |

Appendix B
Shipment Quality Assurance Checklist

Date: _____ Shipper: _____ Destination: _____

Item(s) Description: _____

Radionuclide(s): _____

Radiological Survey Results: surface _____ mrem/hr 1 meter _____

Instrument Used: Mfgr: _____ Model: _____

S/N: _____ Cal Date: _____

Limited-Quantity or Instrument and Article

- | Yes | No | |
|------------|-----------|---|
| _____ | _____ | 1. Strong tight package (package that will not leak material during conditions normally incidental to transportation). |
| _____ | _____ | 2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr. |
| _____ | _____ | 3. Removable surface contamination less than 20 dpm/100 cm ² (alpha) and 1,000 dpm/100 cm ² (beta/gamma). |
| _____ | _____ | 4. Outside inner package bears the marking "Radioactive." |
| _____ | _____ | 5. Package contains less than 15 grams of ²³⁵ U (check yes if ²³⁵ U not present). |
| _____ | _____ | 6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910." |
| _____ | _____ | 7. Activity less than that specified in 49 CFR 173.425. Permissible package limit:
Package Quantity: |
| _____ | _____ | 8. On all air shipments, the statement Radioactive Material, excepted package-limited quantity of material shall be noted on the air waybill. |

Qualified Shipper: _____ Signature: _____

TSOP 2-2

GUIDE TO HANDLING OF INVESTIGATION DERIVED WASTE

Guide to Handling Investigation-Derived Waste

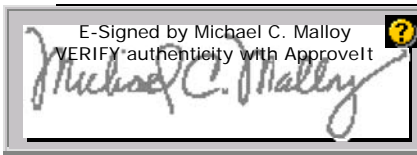
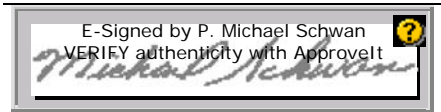
SOP 2-2
Revision: 5
Date: March 2007

Prepared: Tim Eggert

Technical Review: Matt Brookshire

QA Review: Jo Nell Mullins

Approved: _____



Signature/Date

Issued: _____
Signature/Date

1.0 Objective

This standard operating procedure (SOP) presents guidance for the management of investigation-derived waste (IDW). The primary objectives for managing IDW during field activities include:

- Leaving the site in no worse condition than existed before field activities
- Removing wastes that pose an immediate threat to human health or the environment
- Proper handling of onsite wastes that do not require offsite disposal or extended aboveground containerization
- Complying with federal, state, local, and facility applicable or relevant and appropriate requirements (ARARs)
- Careful planning and coordination of IDW management options
- Minimizing the quantity of IDW

2.0 Background

2.1 Definitions

Hazardous Waste - Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-Derived Wastes - Discarded materials resulting from field activities such as sampling, surveying, drilling, excavations, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment. Wastes may be solid, sludge, liquid, gaseous, or multiphase materials that may be classified as hazardous or nonhazardous.

Mixed Waste - Any material that has been classified as hazardous and radioactive.

Radioactive Wastes - Discarded materials that are contaminated with radioactive constituents with specific activities in concentrations greater than the latest regulatory criteria (i.e., 10 CFR 20).

Treatment, Storage, and Disposal Facility (TSDF) - Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the U. S. Environmental Protection Agency (EPA) and appropriate state and local agencies.

2.2 Discussion

Field investigation activities result in the generation of waste materials that may be characterized as hazardous or radioactive waste. IDWs may include drilling muds, cuttings, and purge water from test pit and well installation; purge water, soil, and other materials from collection of samples; residues from testing of treatment technologies and pump and treat systems; personal protective equipment (PPE); solutions (aqueous or otherwise) used to decontaminate nondisposable protective clothing and equipment; and other wastes or supplies used in sampling and testing potentially hazardous or radiologically contaminated material.

Note: The client's representatives may not be aware of all potential contaminants. The management of IDW must comply with applicable regulatory requirements.

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that all IDW procedures are conducted in accordance with this SOP. The site manager is also responsible for ensuring that handling of IDW is in accordance with site-specific requirements.

Project Manager - The project manager is responsible for identifying site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements.

Field Crew Members - Field crew members are responsible for implementing this SOP and communicating any unusual or unplanned condition to the project manager's attention.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

4.0 Required Equipment

Equipment required for IDW containment will vary according to site-specific/client requirements. Management decisions concerning the necessary equipment required shall consider: containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be onsite and inspected before commencing work.

4.1 IDW Containment Devices

The appropriate containment device (drums, tanks, etc.) will depend on site- or client-specific requirements and the ultimate disposition of the IDW. Typical IDW containment devices can include:

- Plastic sheeting (polyethylene) with a minimum thickness of 20 millimeters
- Department of Transportation (DOT)-approved steel containers
- Polyethylene or steel bulk storage tanks

Containment of IDW shall be segregated by waste type (i.e., solid or liquid, corrosive or flammable, etc.) and source location. Volume of the appropriate containment device shall be site-specific.

4.2 IDW Container Labeling

A "Waste Container" or "IDW Container" label or indelible marking shall be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported offsite are:

- Labels and markings that contain the following information: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents (drill cuttings, purge water, PPE, etc.).
- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.
- Containers that are 5 gallons or less may only require one label or set of markings.
- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.
- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the drum color.
- Labels will be secured in a manner to ensure the label remains affixed to the container.

Labeling or marking requirements for IDW expected to be transported offsite must be in accordance with the requirements of 49 CFR 172.

4.3 IDW Container Movement

Staging areas for IDW containers shall be predetermined and in accordance with site-specific and/or client requirements. Arrangements shall be made before field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation offsite onto a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage

Containerized IDW shall be staged pending chemical analysis or further onsite treatment. Staging areas and bulk storage procedures are to be determined according to site-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided for liquid IDW storage and as appropriate for solid IDW storage.

5.0 Procedures

The three general options for managing IDW are (1) collection and onsite disposal, (2) collection for offsite disposal, and (3) collection and interim management. Attachment 1 summarizes media-specific information on generation processes and management options. The option selected shall take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW onsite
- Compliance with regulatory requirements
- IDW minimization and consistency with the IDW remedy and the site remedy

In all cases the client shall approve the plans for IDW. Formal plans for the management of IDW must be prepared as part of a work plan or separate document.

5.1 Collection and Onsite Disposal

5.1.1 Soil/Sludge/Sediment

The options for handling soil/sludge/sediment IDW are as follows:

1. Return to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas).
2. Spread around boring, pit, or source within the area of contamination (AOC) as long as returning the media to these areas will not increase site risks (e.g., direct contact with surficial contamination).
3. Consolidate in a pit within the AOC as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas).
4. Send to onsite TSDF - may require analytical analysis before treatment/disposal.

Note: These options may require client and/or regulatory approval.

5.1.2 Aqueous Liquids

The options for handling aqueous liquid IDW are as follows:

1. Discharge to surface water, only when IDW is not contaminated.
2. Discharge to ground surface close to the well, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background upgradient wells is not a community concern or associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well.
3. Discharge to sanitary sewer, only when IDW is not contaminated.
4. Send to onsite TSDF - may require analysis before treatment/disposal.

Note: These options may require analytical results to obtain client and/or regulatory approval.

5.1.3 Disposable PPE

The options for handling disposable PPE are as follows:

1. Double-bag contents in nontransparent trash bags and place in onsite industrial dumpster, only if PPE is not contaminated.
2. Containerize, label, and send to onsite TSDF - may require analysis before treatment/disposal.

5.2 Collection for Offsite Disposal

Before sending to an offsite TSDF, analysis may be required. Manifests are required. In some instances, a bill of lading can be used for nonhazardous solid IDW (i.e., wooden pallets, large quantities of plastic sheeting). Arrangements must be made with the client responsible for the site to sign as generator on any waste profile and all manifests or bill of lading; it is CDM's policy not to sign manifests. The TSDF and transporter must be permitted for the respective wastes. Nonbulk containers (e.g., drums) must have a DOT-approved label adhered to the container and all required associated placard stickers before leaving for a TSDF off site. These labels must include information as required in 49 CFR 172. Bulk containers (i.e., rolloffs, tanks) do not require container specific labels for transporting off site, but must include appropriate placards as required in 49 CFR 172.

5.2.1 Soil/Sludge/Sediment

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., drummed, covered in a waste pile) or returned to its source until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.2 Aqueous Liquids

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., mobile tanks or drums with appropriate secondary containment) until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.3 Disposable PPE

When the final site remedy requires offsite treatment disposal, the IDW may be containerized and stored. The management option selected shall take into account potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.3 Collection and Interim Management

All interim measures must be approved by the client and regulatory agencies.

1. Storing IDW onsite until the final action may be practical in the following situations:
 - Returning wastes (especially sludges and soils) to their onsite source area would require reexcavation for disposal in the final remediation alternative.
 - Interim storage in containers may be necessary to provide adequate protection to human health and the environment.
 - Offsite disposal options may trigger land disposal regulations under the Resource Conservation and Recovery Act (RCRA). Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.
 - Interim storage may be necessary to provide time for sampling and analysis.
2. Segregate and containerize all waste for future treatment and/or disposal.
 - Containment options for soil/sludge/sediment may include drums or covered waste piles in AOC.
 - Containment options for aqueous liquids may include mobile tanks or drums.
 - Containment options for PPE may include drums or roll-off boxes.

6.0 Restrictions/Limitations

Site Managers Shall Determine the Most Appropriate Disposal Option for Aqueous Liquids on a Site-Specific Basis. Parameters to consider, especially when determining the level of protection, include the volume of IDW, the contaminants present in the groundwater, the presence of contaminants in the soil at the site, whether the groundwater or surface water is a drinking water supply, and whether the groundwater plume is contained or moving. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components.

Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be managed on a site-specific basis. **Under No Circumstances Shall These Types of Materials Be Brought Back to the Office or Warehouse.**

7.0 References

Environmental Resource Center. 1997. *Hazardous Waste Management Compliance Handbook 2nd Edition*. Karnofsky (Editor).

Academy of Certified Hazardous Materials Manager. May 1999. *Hazardous Materials Management Desk Reference*. Cox.

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U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1.

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_____. Region IV. November 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*.

Attachment 1 IDW Management Options

<i>Type of IDW</i>	<i>Generation Processes</i>	<i>Management Options</i>
Soil	<ul style="list-style-type: none"> Well/Test pit installations Borehole drilling Soil sampling 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Return to boring, pit, or source immediately after generation Spread around boring, pit, or source within the AOC Consolidate in a pit (within the AOC) Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Client to send to offsite TSDF <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Sludge/Sediment	<ul style="list-style-type: none"> Sludge pit/sediment sampling 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Return to boring, pit, or source immediately after generation Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Client to send to offsite TSDF <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Aqueous Liquids (groundwater, surface water, drilling fluids, wastewaters)	<ul style="list-style-type: none"> Well installation/development Well purging during sampling Groundwater discharge during pump tests Surface water sampling Wastewater sampling 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Pour onto ground close to well (nonhazardous waste) Discharge to sewer Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Client to send to offsite commercial treatment unit Client to send to publicly owned treatment works (POTW) <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Decontamination Fluids	<ul style="list-style-type: none"> Decontamination of PPE and equipment 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Send to onsite TSDF Evaporate (for small amounts of low contamination organic fluids) Discharge to ground surface <p>Offsite Disposal</p> <ul style="list-style-type: none"> Client to send to offsite TSDF Discharge to sewer <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Disposable PPE and Sampling Equipment	<ul style="list-style-type: none"> Sampling procedures or other onsite activities 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Place in onsite industrial dumpster Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Client to send to offsite TSDF <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal

Adapted from U. S. Environmental Protection Agency, *Guide to Management of Investigation-Derived Wastes*, 9345-03FS, January 1992.

TSOP 3-1
GEOPROBE® SAMPLING

Geoprobe® Sampling

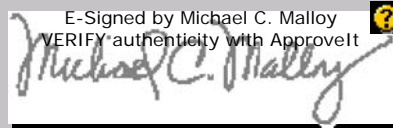
SOP 3-1
Revision: 5
Date: March 2007

Prepared: Kent Hankinson

Technical Review: Frank Morris

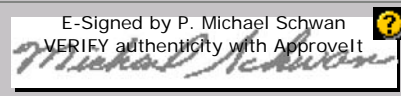
QA Review: Jo Nell Mullins

Approved:

E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt


Signature/Date

Issued:

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt


Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to define the requirements for collecting soil, soil gas, groundwater, and pneumatic slug test data using the Geoprobe® sampling system. Geoprobe is a trade name proprietary to Geoprobe Systems of Salina, Kansas.

2.0 Background

2.1 Definitions

Geoprobe - A hydraulically-operated hammer device installed on the back of a van, pickup truck, or skid used to advance a hollow-stem rod into the soil for the purpose of collecting soil, soil gas, or groundwater samples.

Probe-Drive Sampler - A sampling device, similar to a split-spoon sampler, used to collect soil samples with a Geoprobe rig. Three types of soil samplers are available: standard 25- and 60-centimeter (cm) (10- and 24-inch) length sampler, dual tube (DT), and large bore (with an acetate liner) sampler.

Extension Rod - Stainless steel rod used to remove stop-pin and drive-point assembly.

Extension Rod Coupler - Stainless steel connector used to join sections of extension rods.

Drive Point - Solid steel retractable point used to advance sample collection device to the required sample depth.

Probe Rod - Hollow, flush-threaded, steel rod similar to a drill rod.

Stop-Pin - Steel plug that threads into the top of the drive cap to hold the drive point in place during advancement of the probe rods.

Drive Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when advancing the probe rods with the hydraulic hammer.

Pull Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when retracting the probe rods.

Extruder Rack and Piston - A device used in conjunction with the Geoprobe to force soil sample volume out of the sample tube.

Screen Point Groundwater Sampler - A groundwater sampling device designed for use with the Geoprobe consisting of a well screen encased in a perforated stainless steel sleeve.

Mill-Slotted Well Rod and Point - A groundwater sampling device designed for use with the Geoprobe consisting of a Geoprobe probe rod with 15-mil slots, each 5 cm long by 0.05 cm wide (2 inches long x 0.020 inches wide).

Post-Run Tubing System (PRT) - The Geoprobe soil vapor sampling system uses disposable polyethylene or Teflon tubing (inserted into the probe rods at the desired sampling depth) and a vacuum.

Expendable Drive Point - Solid steel point attached to the end of the screen point groundwater sampler and PRT expendable point holder.

Membrane Interface Probe (MIP) - A screening tool with semi-quantitative capabilities acting as an interface between the volatile contaminants in the subsurface and gas phase detectors at the surface. The membrane is placed in a heated block attached to the probe. Heating the block accelerates diffusion of the contaminant through the membrane into the carrier gas, which flows up hole to the detectors.

2.2 Associated Procedures

- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 1-5, *Groundwater Sampling Using a Bailer*
- CDM Federal SOP 1-6, *Water Level Measurements*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-3, *Well Development and Purging*
- CDM Federal SOP 4-5, *Field Equipment Decontamination*

2.3 Discussion

The Geoprobe unit consists of a hydraulically-operated hammer device mounted on the back of a van, a pickup truck or a skid (Figure 1). The Geoprobe system hydraulically advances small-diameter, hollow rods to the desired sampling depth. The specific type of Geoprobe sampling equipment for soil, soil gas, and groundwater collection is then employed.

The use of Geoprobe technology may be a cost-effective alternative to using conventional drilling techniques for collecting subsurface soil, soil gas, and groundwater samples depending on the site-specific geologic and hydrogeologic conditions and sample requirements. The Geoprobe system is generally used to gather screening-level data. The site-specific sampling plans must consider such factors as soil types, presence of cobbles, depth to groundwater, quantity and depth of samples, site access and topography, data quality objectives (DQOs), analytical requirements, and waste handling and disposal requirements before selecting the use of the Geoprobe.

Advantages of using the Geoprobe Systems include:

- Areas usually considered inaccessible by drill rigs because of overhead wires, steep slopes, size constraints, etc., may be accessed with a van-, pickup truck-, or skid-mounted Geoprobe.
- Investigation-derived wastes such as soil cuttings and purge water are minimized with the Geoprobe due to its small diameter rods and its displacement of soil horizontally, not vertically.
- Pneumatic slug testing is also an option when using the SP15/SP16 groundwater sampler. Analyses of these tests will yield hydraulic conductivity values for the surrounding aquifer materials.

A Geoprobe membrane interface probe (MIP) and integrated electrical conductivity (EC) dipole combination can be deployed with direct push methods to discriminate variation in grain size and volatile organic contaminants (VOCs). As a result, lithologic changes and distribution of contaminants (chlorinated and nonchlorinated) can be determined in the subsurface.

Cost savings over conventional drilling techniques may be realized. The Geoprobe is rented/leased on a daily, weekly, or monthly basis for a fixed price as opposed to drilling subcontractors who are generally compensated based on the footage drilled. For shallow probing, the Geoprobe may be hand- operated by field personnel rather than subcontractors. A cost evaluation based on project-specific requirements and site conditions shall be conducted to determine the most cost-effective method for a particular project.

Two people are required to operate the Geoprobe and conduct sampling and recordkeeping activities. Safety considerations shall be addressed when operating the Geoprobe. A safety hazard is present whenever the Geoprobe is operated. The hydraulic system operates with a fluid pressure of over 907 kilograms (kg) (2,000 pounds per square inch [psi]). A leaking hose may produce a stream of hydraulic fluid with sufficient pressure to penetrate skin. Therefore, periodic checks of the hydraulic lines and hoses shall be conducted to ensure they are in good condition and connections are tight. Do not attempt to repair or tighten hoses with the engine running and the system under pressure. Use paper or cardboard to check for leaks.

3.0 General Responsibilities

Field Team Leader (FTL) - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure, associated SOPs, and the site-specific plans.

Sampling Personnel - Field team members are responsible for conducting Geoprobe sampling events in accordance with this procedure, all associated SOPs, and requirements as described in the site-specific plans.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

General

- Site-specific plans
- Field logbook, chain-of-custody forms, other forms for documenting sample shipment
- Indelible black or blue ink pens and markers
- Sample containers with labels and preservatives
- Insulated coolers
- Bagged ice or "blue ice"
- Plastic zip-top bags
- Waterproof sealing tape
- Temperature, conductivity, pH, dissolved oxygen, and turbidity meters (with clean beakers or other appropriate containers), as required by the site-specific plans
- Monitoring/screening instruments as required by the site-specific health and safety plan or sampling plan
- Decontamination supplies, as required by SOP 4-5
- Personal protective equipment (PPE), as required by the site-specific health and safety plan (at a minimum, hard hat, steel-toed shoes, safety glasses, and hearing protection are required)
- Latex or appropriate gloves
- Geoprobe rig (van, truck, or skid-mounted) with the following:
 - Probe rods 30-, 60-, and 90-cm (1-, 2-, and 3-foot [ft]) lengths
 - Extension rods 30-, 60-, and 90-cm (1-, 2-, and 3-ft) lengths, couplers, and handle
 - Piston stop-pins (two each per rig, minimum)
 - Drive caps and pull caps (two each per rig, minimum)
 - Carbide-tipped drill bit for working in concrete- or asphalt-covered areas
 - O-rings

Geoprobe Soil Sampling Equipment

- Extruder rack and piston (i.e., if soil is to be extruded into a sample container)
- Assembled soil samplers (i.e., standard 25-cm or 60-cm [10-inch or 24-inch] sampler, Dual Tube [DT21 or 325], and large bore sampler. The stainless steel sample tubes or acetate liners from these samplers may be individually sealed and shipped directly to the laboratory, as indicated in site-specific plans)
- Refer to the Geoprobe Systems Equipment and Tools Catalog [2005] for specific parts and accessories for each sampler

Geoprobe Soil Gas Sampling Equipment

- Expendable drive points (one each per sample location, plus spares)
- Extension rod ram
- 10 millimeter (mm) (3/8-inch) polyethylene (Teflon-lined) tubing and PRT adapter
- Vacuum or sampling system
- Syringe
- PRT adapter
- PRT expendable point holder

Geoprobe Groundwater Sampling Equipment

- Expendable drive points (one each per sample location, plus spares)
- Mill-slotted well point or screen point groundwater sampler assemblies
- Extension rod ram
- 10-mm (3/8-inch) polyethylene or Teflon-lined tubing
- Check valves (if using Waterra system)
- Peristaltic pump (limited to shallow depths)
- Mini-bailer (with thin nylon line)

5.0 Procedures

Procedures common to all three sampling methods are discussed below.

Before sampling:

- Review site-specific health and safety plan and project plans before initiating sampling activity.
- Arrange utility clearance.
- Decontaminate all Geoprobe equipment according to SOP 4-5, *Field Equipment Decontamination*.
- Don the appropriate PPE as dictated by the site-specific health and safety plan.
- If the sampling site is in a concrete- or asphalt-covered area, drill a hole using the rotary function and a specially designed 3.75-cm or 5-cm (1.5-inch or 2.0-inch) diameter carbide-tipped drill bit. Otherwise, the area needs to be cleared of heavy underbrush and immediate overhead obstructions.

After sampling is completed:

- Thread the pull cap onto the top probe rod and retract the probe rods.
- Seal the borehole with sand, neat cement, or bentonite grout, if necessary.
- Record all appropriate data in the field logbook and on the chain-of-custody forms as outlined in CDM Federal SOP 4-1, *Field Logbook Content and Control* and CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*.
- Decontaminate the sampling equipment according to CDM Federal SOP 4-5, *Field Equipment Decontamination*.

5.1 Soil Sampling

Assembly

1. Assemble the sampling device as follows:
 - Screw the cutting shoe to the bottom end of the sample tube, unless using standard probe drive sampler which has a built-in cutting edge.
 - Screw the piston tip onto the piston rod.
 - Screw the drive head onto the top end of the sample tube.
 - If using Teflon liner, insert liner into sample tube.
 - Slide the piston rod into the sample tube, leaving the piston tip sticking out of the bottom end of the sample tube.
 - Screw the piston stop-pin onto the top end of the piston rod in a counter-clockwise direction.
2. Attach the assembled sampler onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start the 60-cm (24-inch) standard and large bore samplers.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler. Replace the 30-cm (12-inch) rod with a 90-cm (36-inch) rod as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.
4. Advance the sampler to the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Stop-Pin Removal

5. Move the probe unit back from the top of the probe rods and remove the drive cap.
6. Lower the extension rods into the inside diameter of the probe rods using extension rod couplers to join the extension rods.
7. Attach the extension rod handle to the top extension rod and rotate the handle clockwise until the leading extension rod is screwed into the piston stop-pin. Continue to rotate the handle clockwise until the stop-pin disengages from the drive head.
8. Remove the extension rods and attached piston stop-pin from the probe rods.

Interval Sampling

9. Replace the drive cap, mark the top probe rod with a marker or tape at a distance above the ground equal to the length of the sample tube (either 30 or 60 cm [12 or 24 inches]).
10. Advance the probe rods using the hydraulic hammer the length of the sample tube (either 30 or 60 cm [12 or 24 inches]).
11. Replace the drive cap with the pull cap and retract the probe rod(s). Secure the rod(s) with a clamp or by hand during removal so they do not fall back down the resulting borehole.
12. Detach the sampler from the lead probe rod, verifying that sufficient sample volume was recovered (**Note:** The length of sample contained within the tube is approximately equal to the length of exposed piston rod).
13. Disassemble the sampler. If the sample is to be analyzed for VOCs, then the sample tube or liner shall be sealed immediately by placing a Teflon septa over the ends and covering them with plastic caps.
14. If samples do not require VOC analysis, they may be extruded from the sampler and transferred to the sample jars specified in the site-specific plans or SOP 2-1, *Packaging and Shipping Environmental Samples*. Samples can be extruded by one of two methods:
 - Using the Geoprobe rig and the extruder rack (Figure 2), position the extruder rack on the foot of the Geoprobe derrick; insert the sample tube into the extruder rack with cutting end up; and position the extruder piston, pushing the sample out of the sample tube using the "probe" function. Catch the sample as it exits beneath the extruder in a sample jar or stainless steel mixing bowl.

Note: Samples to be collected for VOCs will be collected directly from the sample tube into the sample jars.

- Lightly tap the side of the sample tube with a hammer while also lightly pushing the Piston Rod.
15. Label the sample liner or sample jars as required, securing the label by covering it with a piece of clear, waterproof tape.
 16. Homogenize the sample in a stainless steel bowl with a stainless steel spoon or spatula. Transfer the sample from the bowl to the sample container.

17. Clean the outside of the sample jars and place individual samples into sealable bags and seal the closure.
18. Place samples in a cooler containing ice according to SOP 2-1, *Packaging and Shipping Environmental Samples*.

Continuous Sampling

The DT 21 is a direct push system for collecting continuous core samples of unconsolidated materials from within a sealed 54 mm (2.15-inch) O.D. probe rods. Samples are collected and retrieved within a liner that is threaded onto the leading end of a string of Geoprobe 25mm (1-inch) O.D. rods inserted to the bottom of the outer casing.

Other sizes are available (i.e., DT325) for maximum sample recovery (up to a 77-inch stroke allowing use of 60-inch probe rods and Macro-Core® [MC5] samplers) depending on the type of direct push unit.

5.2 Soil Gas Sampling Assembly

1. Assemble the sampling device as follows (Figure 3):
 - Test fit the adapter with the PRT expendable point holder or retractable point holder to ensure that threads are compatible and fit together smoothly.
 - Attach the PRT adapter to flexible tubing equal in length to the depth of sampling, with some additional tubing for sampling activities.
 - Secure the PRT adapter with a length of electrical tape and check the condition of the O-ring attached to the end of the PRT adapter.
 - Screw the PRT expendable point holder into the bottom of the lead probe rod.
 - Attach an expendable drive point to the bottom of the PRT expendable point holder.
2. Attach the assembled sampler onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start the 60-cm (24-inch) standard and large bore samplers.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler. Replace the 30-cm (12-inch) rod with a 90-cm (36-inch) rod as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.
4. Advance the sampler to 30 cm (1 ft) past the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.
5. Connect the out-of-hole tubing to a vacuum or sampling system. A short section of inert silicon tubing may be connected to the end of the out-of-hole tubing so that a sample can be collected with a glass gas chromatograph (GC) syringe.
6. Start the vacuum or sampling system and allow the system to operate for 2 to 3 minutes to ensure that a sufficient volume of air has been run through the tubing. Document the depth, vacuum pressure, and purge duration in logbook.
Note: Make sure the vacuum evacuation pump is able to pull vapors from the formation. Excessive vacuum may occur in clay/clayey units resulting in insufficient sample volume.
7. Collect sample using the method specified in the site-specific plan.
8. Label all sample containers as required, securing the label by covering it with a piece of clear, waterproof tape.

9. Remove the tubing from the probe rods. Dispose of the tubing or set it aside for decontamination.
10. Remove probe rod(s) from hole. Leave tubing in place for longer term monitoring.

5.3 Groundwater Sampling Assembly

1. Assemble the screen point groundwater sampler as shown on Figure 4 and described below (see Geoprobe Systems Equipment and Tools Catalog, Groundwater Sampling Tools, pp. 5.1-5.12):
 - Push the screen insert and plug into the screen sleeve from the bottom. The bottom end has one drain hole.
 - Push the screen connector over the top end of the screen sleeve and push the screen connector pin into place. The pin must be held in place as it has a loose fit.
 - Insert the screen sleeve, screen connector first, into one end of the sampler sheath.
 - Slide the drive point seat over the end of the screen assembly that protrudes from the sampler sheath. Thread it in until tight using a 22-mm (7/8-inch) wrench.
 - Push the screen assembly just far enough into the sampler sheath that an expendable drive point can be pushed into place in the drive seat.
 - Screw the groundwater drive head with the O-ring end first into the open end of the sampler sheath.
 - O-rings are installed at various critical places in the sampler assembly. Ensure that all O-rings have not been worn and that the connections made at O-ring locations are tight.
 - The mill-slotted well point does not need any assembly.
2. Attach the mill-slotted well point, or screen point groundwater sampler, onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start either groundwater sampler.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler using either the hydraulic hammer or hydraulic probe mechanism on the Geoprobe rig. Replace the 30-cm (12-inch) rod with a 90-cm (36-inch) rod as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.
4. Advance the sampler to the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Developing and Sampling

6. Move the probe unit back from the top of the probe rods and remove the drive cap.
7. The next step varies depending on the type of sampler being used:
 - Mill-slotted well point - measure and record the water level, allowing time for the water level to reach equilibrium.
 - Screen point groundwater sampler - attach the pull cap to the top probe rod, retract the probe rods approximately 60 cm (2 ft), push the screen into the formation using extension rods fitted with a ram, remove extension rods from the probe rods, and measure and record the water level, allowing time for the water level to reach equilibrium.

8. Surging and purging shall be conducted throughout the length of the exposed screen to properly develop the well point before sampling.
9. Label all sample containers as required, securing the label by covering it with a piece of clear, waterproof tape.
10. Collect groundwater samples using one of three methods (as outlined in site-specific plans) described below:
 - Collect sample from the inside diameter of the probe rods using a decontaminated mini-bailer. Follow CDM Federal SOP 1-5, *Groundwater Sampling Using a Bailer*.
 - Collect sample using a peristaltic pump and flexible tubing system.
 - Collect sample using a check valve (Waterra-type valve) attached to the bottom of 10-mm (3/8-inch) diameter tubing. The tubing is lowered into the probe rods below the top of the water table, check valve-end first. Water sample is collected through the tubing by rapidly oscillating the tubing up and down creating an inertial pump.
11. Clean the outside of the sample containers and place individual samples into sealable bags and seal closure.
12. Place samples in a cooler containing ice according to SOP 2-1, *Packaging and Shipping Environmental Samples*.

5.4 Pneumatic Slug Testing Assembly

1. Assemble the screen point groundwater sampler and the pneumatic manifold assembly as shown on Figure 5 (see Geoprobe Systems Technical Bulletin No. 19344).
2. Be sure to accurately document all well construction parameters and site geologic information:
 - Effective screen length (includes sand or filter pack)
 - Height of water column in well
 - Radius of filter pack
 - Radius of transducer and cable (for wells 1-inch diameter or less)
 - Depth of transducer below static water level
 - Saturated thickness of the aquifer
 - True screen length
 - Screen radius
 - Casing radius
 - Static water level from a fixed reference point
 - Total depth of well from a fixed reference point
 - Initial head change
3. Once the pneumatic head is in place, a vented pressure transducer assembly is installed. The transducer itself is inserted through the port on top of the pneumatic head and lowered into the well about 2-feet below the static water level and off the bottom of the well.
4. Let the transducer equilibrate to ambient groundwater temperature and then zero out the transducer.

Testing

5. Set up slug test data acquisition software and select preferred options (refer to Technical Bulletin No. 19344).
6. Close inlet and release valves and close the pressure regulator on the manifold assembly.
7. Adjust zero setting on pressure gauge, if needed.
8. Operate foot pump to pressurize supply hose to approximately 30 to 40 pounds per square inch (psi).
9. Open inlet valve on pneumatic head.

10. Slowly open the pressure regulator. From the fully closed position it takes about five revolutions to begin opening the regulator. Observe the pressure gauge on the pneumatic head (scaled as inches of water). Let the pressure in the well head rise slowly to a few inches above the level desired for testing (e.g. if you want to initiate the slug test with H₀ of 10 inches let the gauge rise to about 12 inches).
11. Quickly close the inlet valve and allow the pressure observed from the transducer in the well head to return to equilibrium and stabilize. Record the stabilized gauge pressure. The readings shall return to the levels noted before pressurization was started.
12. Leak test the fittings on the pneumatic head and connection to the rods with a soapy fluid. Tighten fittings if necessary and retest. It is preferable to locate and correct any slow leaks before continuing with the slug test.
13. Once the transducer readout is back to equilibrium and stable, the slug test is ready to initiate. The slug test is initiated by opening the release valve as quickly as possible.
14. A very rapid initial drop in the transducer readout (head) shall be observed as the air pressure is released. Then the rise or recovery of the water level to the pre-test equilibrium level (baseline) will occur. Once the water level has returned to the pre-test level and is stable, the slug test is complete.
15. It is strongly recommended that at least three slug tests are run using different initial head values (H₀) to verify appropriate well performance and development. If there is significant deviation between the repeat tests, additional development of the well or sampler may be necessary.

Geoprobe Systems has designed a simple user-friendly software package and data logger that allows acquisition and filing of pneumatic transducer data on a laptop computer. The data files are stored in ASCII format for easy export to spreadsheet and data analysis programs. The selection and application of the appropriate data analysis methods is beyond the scope of this SOP for field techniques.

6.0 Restrictions/Limitations

The Geoprobe sampling system is not designed for collecting large sample volumes, thereby limiting the number of analytical parameters. Soil sample recovery will be poor in soils with substantial amounts of gravel and/or cobbles. Production rates will vary substantially depending on sampling depths/intervals, subsurface conditions, and the platform used. However, a minimum of between 10 and 15 samples per day can be expected in most situations.

The most efficient sampling depth is limited by the geologic and hydrogeologic conditions. Practical, efficient sampling depths shall be limited to approximately 6 meters (20 feet) under most conditions. However, sampling depths in excess of 30 meters (100 feet) have been achieved in unconsolidated, homogeneous sandy soils using heavy duty platforms and MC5 tools. Attainable depths will be greatly reduced in more consolidated and indurated formations and in soils with gravel and cobbles.

The presence of gravel and cobbles in soils will likely damage soil sampling tubes and possibly probe rods, couplers, stop-pins, and other probing equipment. A sufficient supply of replaceable equipment shall be kept on site in the event of damage or breakdowns. Replacement may be at the project's - not the subcontractor's - expense. A copy of the Geoprobe Systems Equipment and Tools Catalog shall also be kept on site; Geoprobe Systems provides overnight deliveries.

Before conducting the Geoprobe sampling event, underground utilities and structures must be demarcated on the ground surface. The local utility companies must be notified at least 72 hours before the scheduled sampling event to allow sufficient time to locate and mark the utility lines. The selected sampling location shall be a safe distance from the demarcated utility. In some cases, records regarding utility locations may not exist. In any event, a good practice is to slowly push the probe rods the first few feet (rather than hammering) to ensure that no utilities, underground storage tanks, or other subsurface structures are present.

7.0 References

Geoprobe® Systems. 1991. *The Probe-Drive Soil Sampling System*. September.

_____. 2002. *Pneumatic Slug Test Kit*, Technical Bulletin No. 19344. February.

_____. 2002. *DT21 Dual Tube Soil Sampling System*, Technical Bulletin No. 982100. June.

_____. 2005. *Equipment and Tools Catalog*.

Figure 1
Geoprobe® Unit

BASICS

- HYDRAULICALLY POWERED PROBE OPERATES FROM HYDRAULIC SYSTEM DRIVEN FROM THE VEHICLE OR AN AUXILIARY ENGINE.
- REMOTE VEHICLE IGNITION ALLOWS OPERATORS TO START VEHICLE ENGINE FROM REAR COMPARTMENT.
- BELT DRIVEN HYDRAULIC PUMP SUPPLIES 10 GPM AT 2000 RPM, 2250 PSI OPERATING PRESSURE.
- PROBE UNIT FOLDS FOR TRANSPORT AND SETS UP AGAIN IN SECONDS.
- UTILIZES STATIC FORCE (WEIGHT OF VEHICLE) AND PERCUSSION TO ADVANCE PROBING TOOLS.
- POWERFUL 8 HP HYDRAULIC HAMMER DELIVERS OVER 1800 BLOWS PER MINUTE.
- HAMMER FEATURES 0-300 RPM LH DIRECTIONAL ROTARY FUNCTION FOR DRILLING SURFACE PAVEMENTS.
- PROBE HAS GREATER THAN 12,000 LBS. OF PULLING CAPACITY.
- DRIVES SMALL DIAMETER (1" O.D. - 1.6" O.D.) PROBING TOOLS TO DEPTHS LIMITED ONLY BY SOIL TYPE AND DEPTH TO BEDROCK, TYPICALLY TO OVER THIRTY FEET.

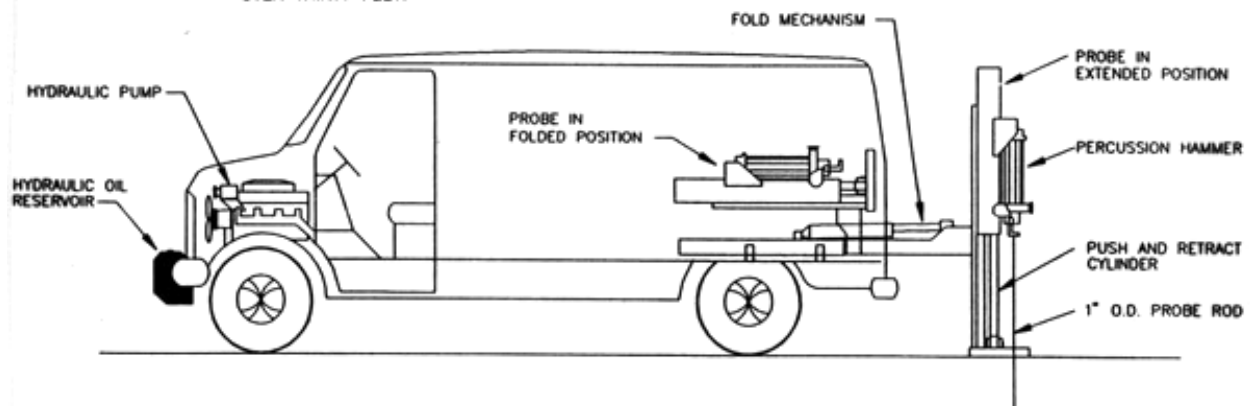


Figure 2
Sample Extruder Rack

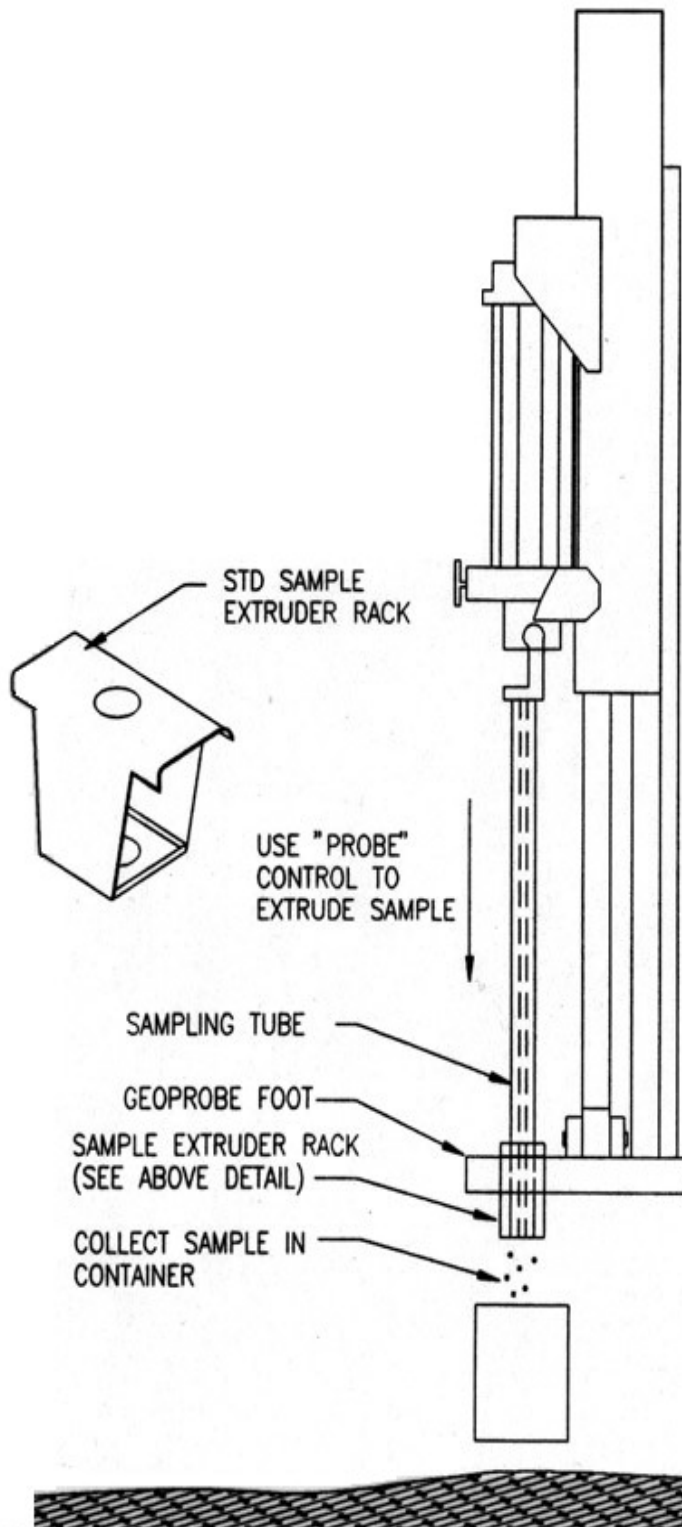


Figure 3
PRT Soil Gas Sampling System

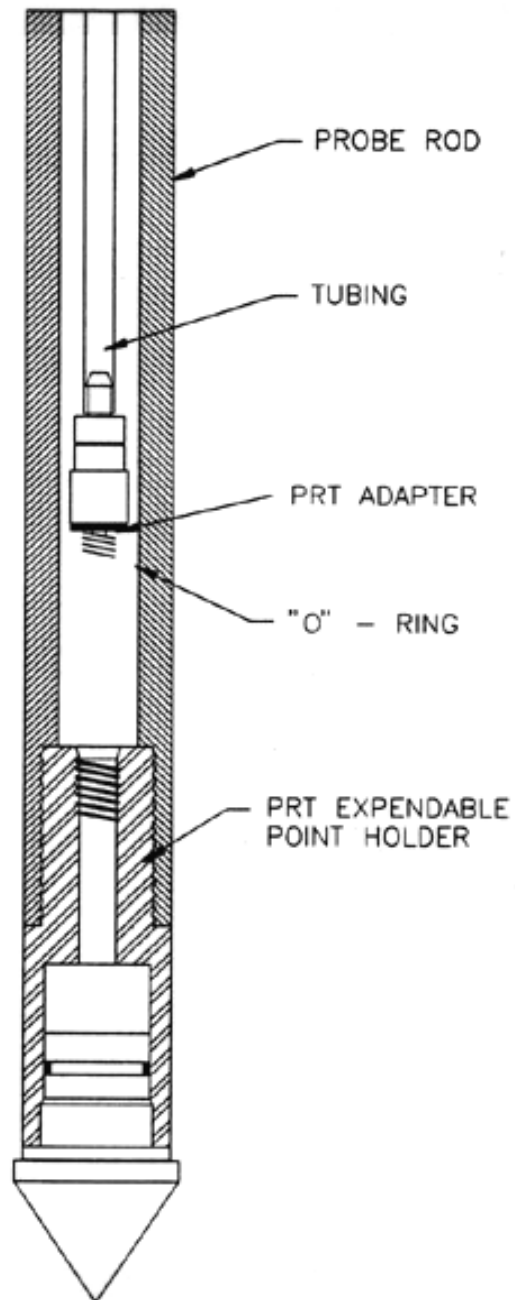


Figure 4
Groundwater Sampling

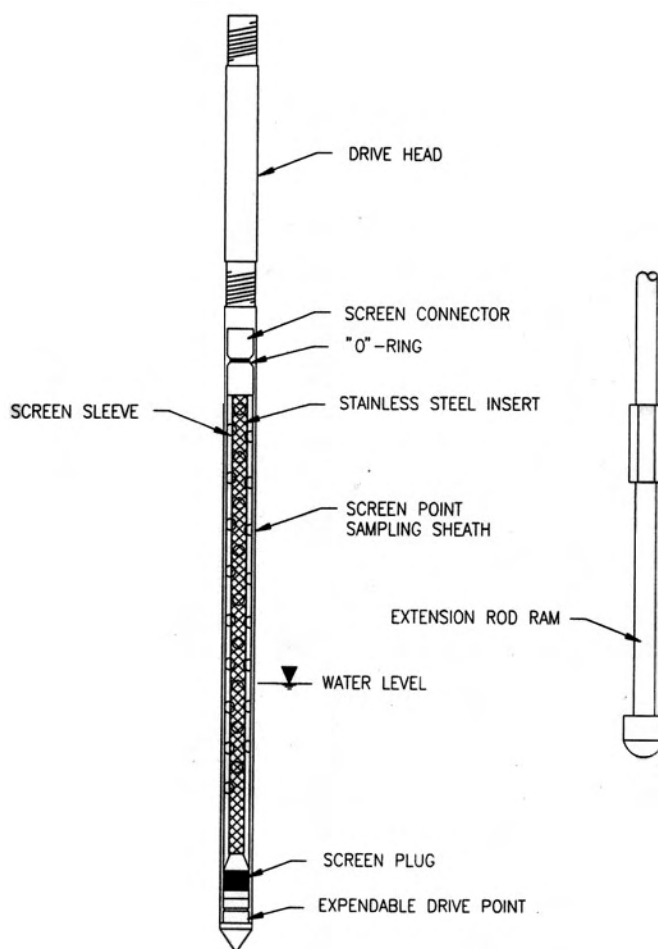
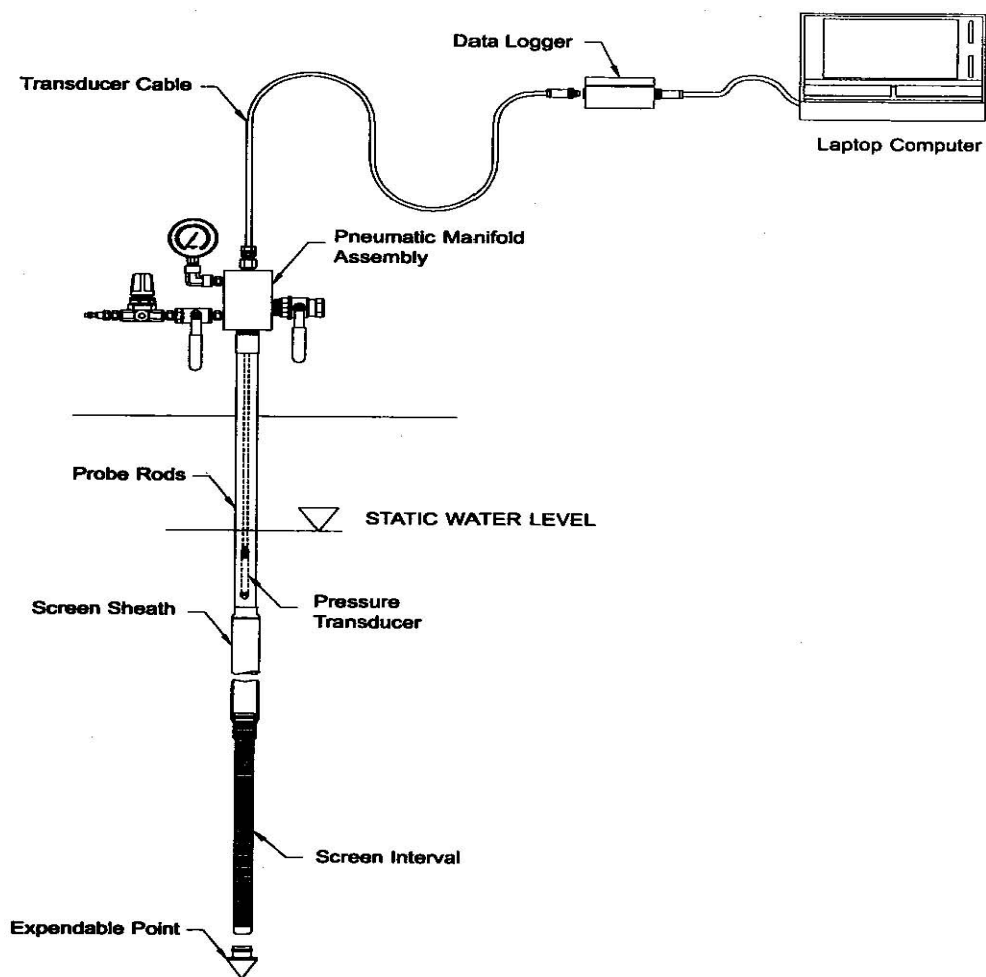


Figure 5
Pneumatic Slug Testing with an SP15/16 Groundwater Sampler



TSOP 3-2
TOPOGRAPHIC SURVEY

Topographic Survey

SOP 3-2
Revision: 6
Date: March 2007

Prepared: Demetrios Klerides

Technical Review: Geoffrey McKenzie

QA Review: Jo Nell Mullins

Approved: 

Issued: 
Signature/Date

Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to provide guidance for a site topographic survey. The survey will produce a base map of the area under study, showing topographic and site-specific features. Also, the base map will incorporate site-specific grid system coordinates, if appropriate, to show sample and exploration location, monitoring wells, test pits, and any other features required by the scope of work.

2.0 Background

A site-specific grid system may be established at the area under study to coordinate the collection of samples. The topographic survey will establish the coordinates for the grid and facilitate the transposition of the grid and sample locations from the field to the topographic base map. At areas where a grid system is not used, sample and exploration locations will be marked by the field team using appropriate markers such as stakes, nails, flagging, or paint. The base map will also locate site-specific planimetric details such as significant manmade and geographic features via the survey.

The scale for the base maps will vary based on the size of the area under study, but a suitable scale will be selected that clearly shows map features and sample locations. The base maps will be at a scale appropriate for the intended use. Areas with significant detail requirements will be shown in scale that ranges from 1 inch equals 10 feet to 1 inch equals 40 feet. Areas with less detail requirements will be shown in smaller scale such as 1 inch equals 100 feet or 200 feet. Topography will be shown with 1- or 2-foot contour intervals. However, the contour interval shall clearly identify the variation in topography to the degree necessary for the work to be performed. For example, gently sloping areas may require a smaller contour interval (i.e., 1 foot between contour lines) to reveal more subtle topographic variations. Similarly, steeply sloping areas may require larger contour intervals to legibly depict the topography. Index contours shall be indicated at elevations that are multiples of five times the contour interval.

If appropriate, aerial photographs may be used to assist in the development of the topographic base maps. Existing or new photographs can be used for this purpose. In areas with deciduous trees, new photographs shall be taken during late fall or winter when the leaves are off the trees and better ground surface image can be achieved. The scale of the aerial photographs shall provide sufficient detail for developing the topographic base map.

3.0 General Responsibilities

Project Manager - The project manager is responsible for ensuring that the topographic survey is completed in accordance with the project requirements.

Field Team Leader - The field team leader is responsible for developing the survey scope of work and ensuring that the topographic survey is coordinated properly with the grid system (if used) and the sampling points, so that the base map produced is a true representation of the field locations.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-specific/project-specific quality assurance plan.

4.0 Required Equipment

The required equipment for a topographic survey shall be provided by the selected surveyor. All equipment proposed by the surveyor shall be submitted to CDM for approval before initiating the topographic survey work.

The selected surveyor must be licensed in the state in which the survey is conducted.

For topographic surveys conducted at hazardous waste sites, all surveyor personnel who work onsite will be 40-hour health and safety trained per OSHA requirements for hazardous waste sites (29 CFR 1910.120), unless approved differently by the corporate health and safety manager.

All final drawings and maps must be signed and sealed by the licensed land surveyor.

5.0 Procedures

1. A site visit may be conducted before submitting the bid proposal. A kickoff meeting shall be held between the selected surveyor and CDM's project manager to discuss the specific requirements of the scope of work.
2. The surveyor shall be responsible for executing the work, including deed search if required.
3. The surveyor shall develop and implement a site-specific health and safety plan according to the requirements specified in the subcontract between CDM and the surveyor.
4. To the extent practical, the work shall be performed in the presence of an authorized representative(s) of CDM. CDM will interpret and clarify the specifications and will answer all questions in connection therewith.
5. The CDM field team leader will be responsible for ensuring that appropriate calibration procedures are performed and documented by the surveyor. Calibration procedures shall be consistent with the data quality objectives for the survey and with the equipment manufacturers' requirements.
6. The surveyor shall establish at least one primary horizontal control monument and one vertical benchmark, as established by the United States Coastal and Geodetic Survey (USC&GS) or equivalent authority. Additional monuments may be established by the surveyor.
7. Local benchmarks will be established at least every 500 feet or closer, if warranted by site conditions, to tie the basic control points together. Where required, established horizontal and vertical data, such as state planar coordinate systems and the national geodetic vertical datum of NAVD 88 or subsequent corrections and/or revisions, shall be used to tie the survey data to the national network.
8. Temporary monuments will be set as necessary to perform the surveying. They may be wood, metal, or otherwise marked on facilities such as sidewalks, paved streets, curbs, etc. All monuments shall be described in the field notes and marked on site maps for future reference.
9. If appropriate, the surveyor shall be encouraged to use technologies such as Global Positioning System (GPS) that will meet the accuracy requirements but that may be more flexible and efficient than traditional techniques. All geodetic control work shall conform to either the Standards and Specifications for Geodetic Control networks, Federal Geodetic Control Subcommittee or NAVSTAR Global Positioning System Surveying, U. S. Army Corps of Engineers, for third order Class II control surveys. Short traverses, less than 1 mile, may use generally accepted fourth order techniques (including vertical angles for elevations) that will provide the spatial accuracy required. Angles shall be doubled and redoubled if the mean of the doubled angle differs from the first angle by more than 10 seconds. Length measurements shall be made with a calibrated tape corrected for temperature and tension or with Electronic Distance Measuring (EDM) equipment corrected for variation of the index of refraction.

Topographic Survey

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10. The CDM field team leader will review the draft map to ensure that all sampling and exploration locations, grid coordinates, and other appropriate features are located by the surveyor. The surveyor will record all field survey information in a field logbook; a copy of the logbook shall be provided to CDM with the submittal of the topographic map.
11. A working drawing of the base map will be field checked and corrected by the surveyor as necessary. The completed topographic base map shall be plotted on Mylar® or other suitable drafting film, as directed by the CDM project manager. All survey and topographical data will be in digital format, compatible with the latest version of AutoCAD, ArcView/ArcInfo, DXF, or geographic information system (GIS) export format may also be acceptable. The specific format of the data to be provided to CDM will be specified in the SOW. It is recommended that a review of CDM client requirements be completed to determine the appropriate data format. Sufficient documentation of the digital information shall be provided to explain the data. For clarity, the surveyor will prepare the base map with groups of features on separate layers in the AutoCAD files. The CDM project manager shall designate which features will be placed on the separate layers. Tick marks indicating the latitude and longitude in the state that the work is performed shall be provided on the base map. The project manager will be responsible for ensuring that the topographic base map and digital information is completed according to CDM's drafting standards for the project.
12. In the event that aerial photographs are used, the surveyor shall field edit and statistically test the aerial topographic mapping of the site base map for conformance with the horizontal and vertical components of the National Map Accuracy Standards. The surveyor shall run random baselines throughout the site (minimum of four) to verify that less than 10 percent of horizontal and/or vertical locations exceed the values determined in the National Map Accuracy Standards. If more than 10 percent of the locations exceed the values in the National Map Accuracy Standards, then the surveyor will notify CDM.
13. Stereo map compilation by stereo photogrammetric methods will be accomplished through the use of approved stereophotogrammetric instruments using professionally recognized plotting ratios for each type of instrument. Fully trained and experienced photogrammetrists will be employed to complete stereomap compilation.
14. For broad area high precision topographic mapping, digital elevation/terrain model compilation using light detection and ranging (LiDAR) technologies is becoming more common. This method can be an efficient and effective tool for increasing engineering production at all levels. However, the error budget for a given LiDAR mapping system is dependent on the accuracy of its core subsystems (i.e., the laser rangefinder, the GPS position solution, and the inertial measurement unit [IMU]). System engineers need to balance each subsystem contribution against desired system performance (Shrestha et al. 2000).
15. The surveyor shall establish and maintain a quality control program to ensure that the survey is performed within acceptable limits. At a minimum, the surveyor will:
 - Check all equipment, including compasses, transits, and levels, for accuracy and maintain records of such checks. The surveyor will make records of these checks available to CDM on request.
 - Maintain and submit copies of all survey field notes.
 - Field notes for each surveying activity will be kept in bound books dedicated exclusively to this project. Each book will have a table of contents. Each page of field notes shall be numbered, dated, and show the initials of all crewmembers. Black waterproof ballpoint pens will be used. Erasing is not acceptable. All errors will be crossed out with a single line and the correct data entered adjacent to the error. The crossed out and corrected data will be initialed by the party marking field notes.
16. Permits:
 - The surveyor shall be responsible for obtaining any federal, state, and local permits that may be required and to perform and complete the ground surveys at the site.
 - The surveyor shall not perform any work until permits (if required) are obtained.
 - The surveyor shall provide separate copies of all permits to CDM before performing any onsite activities.

6.0 Restrictions/Limitations

The horizontal positions are to be surveyed within 1/10 of a foot, relative to the datum coordinate system. The vertical elevations of monitoring wells, piezometers, and staff gauges are to be surveyed within 1/100 of a foot (0.01 foot), relative to the local benchmarks. The vertical elevations of all other sampling points are to be surveyed within 1/10 of a foot, relative to the local benchmarks.

7.0 References

U. S. Department of Commerce, National Geodetic Survey (see <http://www.ngs.noaa.gov>).

Moffitt, F.H. and Bouchard, H. 1982. *SURVEYING* (7th ed.), Harper and Row, Publishers, New York.

Shrestha, R. L. et al. 2000. *Airborne Laser Swath Mapping: Accuracy Assessment for Surveying and Mapping Applications*. University of Florida (see <http://www.alsm.ufl.edu/pubs/accuracy/accuracy.htm>).

TSOP 3-4

GEOPHYSICAL LOGGING, CALIBRATION, AND QUALITY CONTROL

4.0 Required Documentation

- Field logbook
- Appropriate log sheets (boring logs, well completion data sheets, or equivalent)
- File containing:
 - a) One copy of the logging contract stating the technical requirements
 - b) One approved copy of logging subcontractor SOPs and emergency operating procedures
 - c) One copy of the current Nuclear Regulatory Commission (NRC) license listing certifications and approval of the type and activity level of the radioactive sources to be used onsite, if appropriate
 - d) One copy of the current leak test (swipe) results of all radioactive sources containers on board the logging vehicle
 - e) Physical survey forms indicating activity level at monitoring points adjacent to the radioactive source storage area of the logging vehicle
 - f) Documentation of current radiation monitoring instrument calibration
 - g) Documentation that all geophysical tools have been inspected and are properly operating
- Site-Specific Checklists (see attached examples)
 - a) Health and Safety Checklist (Attachment 1)
 - b) QA Geophysical Checklist for Borehole Logging (Attachment 2)
 - c) Geophysical Logging Tool Checklist (Attachment 3)
 - d) Example Log Heading (Attachment 4)

5.0 Procedures

5.1 Preparation

The site-specific health and safety plan shall be reviewed along with project plans before initiating logging activities. The logging subcontractor and the FTL or designee will confer before field activities regarding the suite of geophysical tools to be used in the operation. The FTL shall define what logs are to be used.

Considering the objectives of the logging program, the choice of tools may be further determined by the lithology surrounding the borehole and the borehole conditions. Prior logs will be used, if available, as aids to determine the appropriateness of the logging suite. These logs will be studied and serve as a baseline for the current logging activity.

Generally, fluid logs are run first within a logging suite with nuclear logs last. In uncased holes, a caliper log shall be run shortly after the fluid log, as it can yield measurements of the borehole rugosity and diameter variations useful in the onsite evaluation of uncompensated logs that may follow. Both are necessary in determining the borehole integrity and appropriateness and suitability of future logs.

The logging subcontractor shall have an approved emergency operating procedure covering all emergencies relating to tool operation, including the retrieval of a logging tool that has been lost down a hole. The logging subcontractor and FTL or designee will cooperate in determining the most suitable approach for retrieval of any tool.

Note: Some sites (such as the U. S. Department of Energy) require advance notification and approval before bringing any radiation source onto the site. This includes radioactive calibration check sources. The FTL will confirm that all site-specific requirements are met before mobilization of the logging equipment.

The following documents, certificates, and inspections will be completed by the logging subcontractor before well logging and shall be in an open, active file during logging activities.

- One copy of the current NRC license listing certifications and approval of the type and activity level of the radioactive sources to be used in the logging program.
- One copy of the current leak test (swipe) results of all radioactive sources containers on board the logging vehicle.
- Physical survey forms indicating activity level at monitoring points adjacent to the radioactive source storage area of the logging vehicle.

Geophysical Logging, Calibration, and Quality Control

(Includes Potential Radioactive Sites)

SOP 3-4

Revision: 5

Date: March 2007

Prepared: Charles Callis

Technical Review: Michael Valentino

QA Review: Jo Nell Mullins

Approved: 

Issued: 
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to provide guidelines and define requirements for the generation of quantifiable geophysical logs of selected boreholes. The procedure defines use of a logging systems check, calibration and maintenance check, and well maintenance data documentation.

2.0 Background

Geophysical logging can be used to interpret the physical characteristics surrounding a borehole. These characteristics include the lithology, geometry, resistivity, formation resistivity factor, bulk density, porosity, permeability, structural integrity, and moisture content. Logging can also be used to evaluate well integrity and characterize vertical groundwater flow and groundwater quality within the water column. Interpretations from tool response can be used in a more quantitative fashion when the instruments used during a specific logging process are accurately and properly calibrated and operated by trained personnel. To provide consistently reliable data, a logging operator needs to ensure the following: proper tool calibration or standardization maintenance checks, a logging systems check, complete and well-maintained data documentation, and identification and protection against potential hazards.

2.1 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

3.0 General Responsibilities

Site Manager - The site manager translates client requirements into technical direction of the project. The site manager plans and directs the overall project; sets technical criteria; reviews and approves technical progress; defines or approves what logs and tools are to be used after consultation with the field team leader; and considers the objectives of the project, the lithology surrounding the borehole, and the borehole conditions.

Field Team Leader - The field team leader (FTL) provides onsite supervision of the borehole logging program, administers the logging subcontractor operation, and ensures that this SOP is properly followed at all times. The FTL confers with the site manager and the logging subcontractor on what logs and tools are to be used and maintains the field logbook in accordance with CDM Federal SOP 4-1, *Field Logbook Content and Control*. The field team leader provides the logging subcontractor with a unique, site-specific document control or ID number for use in identifying each individual borehole or well, provides copies of checklists pertinent to the operation, and provides copies of borehole or well construction details.

Logging Subcontractor - The logging subcontractor provides equipment appropriate to the task as described in the project statement of work, provides appropriately trained and qualified personnel, and responds to administration of the FTL. The logging subcontractor ensures proper tool calibration or standardization maintenance checks, a logging systems check, complete and well-maintained data documentation, and identification and protection against potential hazards. The logging subcontractor ensures that logging subcontractor personnel read and observe requirements defined in this SOP and provides copies of their company standard and emergency operating procedures for approval by FTL before implementing any logging activities.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

Geophysical Logging, Calibration, and Quality Control

(Includes Potential Radioactive Sites)

SOP 3-4

Revision: 5

Date: March 2007

- Documentation of current calibration of radiation monitoring instrument.
- Copy of the logging SOP and emergency operating procedures to be followed during logging activities. Emergency procedures shall include provisions for retrieval of lost probes, with physical descriptions and drawings of the probes and head connections available at the well site.
- Documentation that all geophysical tools have been inspected and are properly operating.

Before proceeding to the field site, each geophysical logging tool will be "shop calibrated." The shop calibration (or standardization) is a method of subjecting the energized probe to a known signal level to ascertain the integrity of the logging equipment. These offsite standardization trials will be available for comparison to onsite calibration or standardization, which will be performed before and after each logging tool run. American Petroleum Institute (API) calibration scales are not usually applicable to geophysical logs made in cased holes, and log headings, in such cases, shall not exhibit environmental units or any other nonapplicable scales. Radiation logs, made through steel casing, shall display nonenvironmental "shop calibration" scale units, such as counts per second, counts per minute, or API units.

5.2 Operation

After all required equipment and material have been mobilized onsite and necessary consultations and preparations are completed, the field operations may begin. During field activities, to ensure the safety and quality of operations, a Health and Safety Checklist (Attachment 1) along with a QA Geophysical Checklist for Borehole Logging (Attachment 2) shall be completed.

Once at the site, each piece of logging equipment will go through routine standardization before and after the logging of every borehole using portable standards. All tool responses to each standard will be recorded on each borehole log trace. Personnel responsible for running the geophysical log shall perform the standardization of the logging equipment.

Calibrations and standardization will be recorded as untransformed (analog) log data (nonenvironmental units). A conversion factor or graph will accompany these data and be used to convert the raw data to environmental units. Analog to digital (A/D) conversion will be done onsite to more easily assess any problems that may arise and to implement immediate correction.

Mechanical and electrical zero response and full scale settings will be recorded and labeled as such at the beginning of each logging trace.

Before logging any borehole, the FTL or designee will review the most up-to-date information on borehole conditions such as: depth, variations in diameter, lost circulation zones, casing, debris in hole, fluid type, and known contaminants (if any) in the borehole. Each logging procedure will be determined based on assessment of borehole conditions using the most recent and previously run logs (if available).

All probe O-ring seals will be thoroughly inspected to prevent potential water leaks from developing within the instrument. Seals shall be clean and dirt free.

All logging cables need to be kink free. Logging subcontractor personnel shall be prepared to wipe or clean cables before retraction onto the storage drum.

The cable measuring sheave between the winch and well must be pre-calibrated to the currently used cable size. The sheave shall be free of any debris (e.g., dirt, ice, or dry drilling mud).

Cable heads shall be checked for electrical leaks or shorts using a volt- or ohm-meter.

Before the completion of each logging suite, a geophysical checklist will be studied and completed, where appropriate, by the FTL or designee. All checklists will be completed in black indelible ink. The Geophysical Logging Tool Checklist (Attachment 3), to be completed by the logging subcontractor equipment operator, shall indicate the specific logging tools used, order of use, and the combination of tools used concurrently. A preview of the checklist by the logging subcontractor equipment operator will serve, in part, as a reminder of potential problems that may arise during the logging run.

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An example log heading, as shown in Attachment 4, shall be used. The analog trace for each log will have all pertinent information (listed below) written on the trace by the logging subcontractor equipment operator as it occurs. This may include:

- Depths per interval or division of log tracing paper
- Horizontal scale values (written at the start of each log)
- Scale changes (if done during a logging run)
- Pen positions
- Borehole/well identification
- Probe type
- Logging speed
- Tool calibration tails
- Module adjustments
- Digitized record information number

This information will be copied to a formal well log heading at the end of the logging run. Each log heading will give information relating to well and geophysical tool parameters. To interpret the well log as quantitatively as possible, it is imperative that all criteria and data entries within a log heading be filled out by the logging subcontractor equipment operator before the logging tool is removed from the cable. The completed heading will be attached to the well analog record at the well site. If required for the project, the FTL or designee may supply a unique site-specific document control or ID number written on both analog record and the log heading.

Analog and digital data records will be run as follows:

- A minimum of two independent log channels will be available to record analog data, thus permitting two traces to be recorded using different gain and baseline values. Recorder channels shall have wraparound capabilities if the trace exceeds chart span.
- The raw analog data will be converted to or recorded as a digital record onsite. Raw conversion (if required) of the analog record to digital form will allow easy data interpretation such that quick module adjustments can be made if a problem arises. The sample time and interval of the digitized record will coincide with that of the raw analog data. The digitized record will be stored on CD ROM. This will provide an onsite backup record if the original analog record is damaged or lost. The digital sample time must be predetermined before conversion and must be consistent with the onsite sample interval and time. The digitized version of the borehole record will have a document control number that will be referenced on the analog record. The analog record, in turn, will refer to the digital record label, file number, sample interval and time, and recorded depth interval. The original of records will be given to the FTL or designee. Copies shall be maintained by the logging subcontractor.

It is imperative that the logging operator continually monitor the data output of the strip chart recorder, monitor, or logging film to determine any spurious and anomalous conditions that may arise. A review of the geophysical checklist before logging will be done to prompt the logging subcontractor equipment operator of potential problems that might arise. The following briefly summarizes some of the potential problems associated with each logging technique. It shall not be a substitute for thorough training in the nuances and idiosyncrasies of specific instruments, as each tool used will have a unique circumstance that may result in a spurious log.

A. Scaling of Recording Equipment

Several problems may arise in log interpretation if horizontal and vertical scales on the strip chart recorder have not been properly set on the recorder at the beginning of the log run. While logging, repeated checks must be made to ensure readings from the depth indicator agree with chart paper divisions.

Horizontal and vertical scales need to be preset before the log run and tested within the range of expected borehole responses.

During setup time, the horizontal log scale will be written on the log paper and the depth of major chart divisions will be clearly marked as logging progresses. Knowledge of well conditions is helpful in determining the proper horizontal and vertical scale.

If during a log run the horizontal or vertical scale is determined to be insufficient and an adjustment needs to be made, it will be necessary to stop and restart the logging from the starting depth.

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B. Extraneous Conditions Resulting in Anomalous Logs

The following briefly describes conditions that may give rise to anomalous log traces and shall be watched for by the logging subcontractor equipment operator.

1. Fluid Logging

In newly drilled holes, it is unusual to have chemical or thermal equilibrium between the borehole fluid and surrounding borehole matrix. Consequently, fluid logs generally measure the conditions of the borehole fluid rather than borehole matrix that sometimes requires months to reach equilibrium (this would be especially true if the hole was drilled using drilling mud and development was not properly performed).

Temperature Logs

The introduction of fluid or air to remove drill cuttings during the drilling operation causes false temperature anomalies often requiring months to reach equilibrium. Foreign material introduced into the annulus, especially curing cement, causes anomalies not related to formation properties. For these reasons, temperature logs in recently drilled holes shall not be interpreted as formation temperature logs. Temperature logs are not easily repeated due to disturbance of the fluid during initial entry. Therefore, formation or fluid temperature logs shall be done first and recorded as the probe descends down the borehole, generally long after the well has been developed.

Typical thermal gradients shall range between 0.47°C and 0.6°C per 30 meters (m) (100 feet) of well depth. If a log results in temperatures outside this range, extraneous effects affecting the log shall be considered. In rare instances, a log may be erroneous due to problems that arise within the probe such as thermal lag, electronic drift, and self-heating of the probe thermistor. Since these conditions are the exception and not the rule, other conditions shall be examined first as a result of questionable temperature logs.

Log traces that result in small temperature fluctuations near the fluid surface may arise from large diameter probes descending too fast within the borehole and may not be representative of borehole conditions. Small temperature fluctuations with respect to depth may be a result of borehole conditions rather than improper tool operation. Inter-bore flow due to large head differential between aquifers can cause very small or even reversal of the thermal gradient. Fluid tracers or flow measurements may help to determine these effects.

Convection cells within the borehole can result in temperature readings that are unrelated to the flow of water within the borehole. This is especially true for boreholes that have large diameters, fracture zones, and washouts. Consequently, the more accurate temperature logs are taken in small boreholes with small diameter probes.

Conductivity Logs

Conductivity logs measure the fluid conductivity within the borehole and are not always a measurement of interstitial water conductivity. Temperature drifts and movement of the probe in and out of steel casing material may give rise to sharp log deflections.

Flow Logs

Impeller flow-meters (commonly called spinners) are generally less sensitive than heat pulse or tracer release methods. In many aquifers, water movement is predominantly in the horizontal direction, with substantial seepage velocity variations as a function of vertical position. In these cases, knowledge of hydraulic conductivity with vertical position is essential. These conditions can be investigated best by installing the impeller flow-meter below an operating pump or in flowing artesian wells. Inter-borehole flow can often be determined by the heat pulse or tracer release methods.

2. Caliper Logs

Caliper log errors shall be questioned when one of the arm traces shows no deflections. Several conditions are suspect. Heavy drilling muds, most prevalent at the bottom of the borehole, can cause failure of caliper arms to open up.

Nonextended arms may be jarred open by bouncing the probe up and down or simply moving the probe to a zone with thinner muds.

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Boreholes with a large degree of rugosity may give rise to peculiar log traces, especially in arm-averaging traces. For these types of holes, it is recommended that nonaveraging or a single arm caliper be used. When a single arm caliper is used, repeat logs may not be exact duplicates of one another due to potential probe rotation.

Electrical leakage and grounding problems may cause spurious trace spikes.

3. Electrical Logging

Spontaneous Potential (SP) Logs

Stray electrical currents caused by underground cables, lightening strikes, corroding underground pipes, and nearby electrical motors can affect SP logs, inducing spikes or a uniform cyclical response. A repeat log will need to be done shall such interferences occur.

If the logging cable has become magnetized, the log trace will consist of a cyclical sinusoidal wave that corresponds to each revolution of the cable winch. The cable shall be demagnetized and the log rerun.

Single Point Resistance Logs

Single point resistance logs are affected by electrical fields generated from underground cables. Alternating current from the underground cable becomes superimposed over the alternating current applied to the probe. This can be detected when the trace pen fluctuates when the probe is stationary. The problem can be alleviated by changing the current frequency applied to the probe electrode and double-checking while the pen is stationary.

Normal Resistivity Logs

Nearby underground cables with currents of 60 cycles per second will produce an oscillating periodic logging trace. This problem can be alleviated by changing the current frequency applied to the probe from the generator or other power source.

A logging trace that appears to be cupped, or reversed, may be the result of an electrode spacing that is greater than the formation thickness.

Induction Logs

Problems will arise if the resistivity of the formation water is five times greater than the resistivity of the borehole fluid. As a double check, the inverse of induction measurements shall be in close agreement with formation resistivity measurements taken with other instruments.

4. Acoustical Logging

Acoustical televiewer (ATV) logging relies on a rotating trigger switch that is activated when a sensor passes magnetic north. Lithologic formations that are composed of magnetized material, lost drilling equipment in the borehole, and metal casing will cause the switch to malfunction. Therefore, the logging operator will need to change the trigger switch to a mechanical mechanism if they suspect the presence of magnetically susceptible materials.

Boreholes that deviate from the vertical will require careful corrections on the ATV log; these corrections shall be noted on the logging trace. If the probe is not properly centralized, dark splotches will appear on the log. This may be exacerbated when coupled with low gains.

Acoustical logs are questionable when the log trace is composed of rapid fluctuations labeled as cycle skipping. This may be a result of several conditions, such as gains that are too small or too large. For example, an amplitude that is too small will result in the first compression wave being masked by pre-arrival "noise." Skipping may also be a result of borehole fractures, solution openings, attenuating rocks, or gas in the borehole fluid.

5. Nuclear Logging

All nuclear logs will be run near the end of the logging suite. Borehole conditions will be carefully scrutinized for integrity and their suitability for nuclear logging during previously run logs within the logging suite. Confirmation that the borehole is suitable for nuclear logging will be between the FTL or designee and the logging operator. This will be noted on the nuclear logging checklist.

Any suspicions of potential problems arising during a nuclear log operation will be addressed immediately and resolved before further nuclear logging is carried out.

The following paragraphs briefly describe conditions that may give rise to anomalous nuclear log traces and shall be watched for by the logging operator.

Natural Gamma (Gamma Ray) Logs

The natural gamma log trace shall have maximum deflection with minimal statistical variation. Pulses of natural gamma radiation are collected and averaged over a predetermined time constant. If the time constant is too short, relative to the amplifier gain, the trace will be masked by spikes of statistical variation. If the time constant is too long, relative to the probe travel and amplifier gain, the log trace is rounded off and lacks resolution. Logging speed and time constant setting shall produce a trace with sharp anomalous peaks, with a minimum of clutter and maximum horizontal span.

Natural gamma logs are sensitive to borehole configurations and packing materials. Sudden trace deflections or changes in amplitude may be due to borehole diameter irregularities and drilling or well construction fluids; consequently, all gamma traces must be checked with a caliper trace.

Migration of water containing radioactive colloidal particles (i.e., clays or sylvite) through the borehole cracks and fissures will give traces that are not representative of the borehole matrix.

Gamma-Gamma (Gamma Density) Logs

Gamma-gamma logs are affected by borehole configuration, casing, cement, mud, probe "stand off," and background radiation. Therefore, a high resolution caliper log and background radiation check shall always be compared with the gamma-gamma log trace to differentiate whether the trace response is due to matrix porosity and density parameters or extraneous effects.

A 4-pi gamma-gamma density log, because of its capability to propagate energy in four directions, is very effective in evaluating the integrity of material placed between the well casing and borehole walls. A thorough background check is especially critical to the success of this logging technique.

Attention shall be given to sharp trace deflections. These shall be compared to other logs as they may be due to the presence of cement boundary zones, the threaded interface between casing lengths, casing nested strings, and gravel packs. In the case of the 4-pi density log, these anomalous features are the target.

Neutron Logs

Neutron logs are affected by the same borehole parameters as gamma-gamma logs (except borehole casing materials) but less dramatically. As with gamma-gamma logs, cross checks between high-resolution caliper logs, background radiation, and the neutron log shall be performed to adequately interpret the trace.

Large trace deflections will occur at the interface between fluids of different densities, such as a saline/fresh water or air/water interface.

The presence of clays and shales surrounding the borehole will give anomalously low trace responses, indicating high total porosity.

5.3 Post Operation

All checklists shown in this SOP's attachments shall be filled out before leaving the site. These checklists are designed for health and safety, quality assurance, and tool operation.

At the end of each logging run (within a suite), the logging operator will complete the appropriate portions of the tool checklist. The checklist will then be verified by the FTL or designee. Any correction in data entry will be crossed out with a single line, dated, and initialed. At the end of the logging suite, each category in the checklist will have a handwritten entry. If a specific parameter does not apply, the logging operator will enter "N/A" by that category.

The original of all records will be given to the FTL or designee along with copies as may be specified. Copies of all completed checklists will also be provided.

To check for leaks, a radiation survey will be done on all nuclear probes. Shields will be checked for proper installation and defective components before probe storage. If shields of neutron sources have been found to be defective, storage before repair will be away from sodium-iodide crystals (a common component in some probe detectors) as they become radioactive when impinged upon by a neutron source.

All radioactive sources and radioactive tracers will be kept in a designated and carefully monitored storage area that has been specifically designed for storing or transporting nuclear sources. Sources stored within the facility will be sealed and placed in source holders specifically designed for their use. Each storage container will be clearly labeled with the following information: source material, concentration in Curies, and dose rate at 1 meter from the holder. Labels, warning signs, and alarms for source containers and the storage facility will follow that prescribed by the NRC. The storage facility and source containers will not be altered in any way, and both will be locked when unattended.

Each probe will be securely fixed to a stand or other similar structure where it will be cooled, cleaned, and inspected for damage. Repairs will be made when possible. If the probe cannot be repaired onsite, a note will be made of this on the tool checklist and the tool will be labeled "out of service" until repairs can be made.

The site will be checked for any debris, spills, or litter resulting from logging activities. All such matter will be removed and disposed of in accordance with regulations applicable to the site.

5.4 Cleaning and Decontamination

All equipment brought onto the site shall be clean and free of leaking oil, grease, or hydraulic fluid. Equipment that may contact the interior of the borehole shall be cleaned and decontaminated in the designated decontamination area. Downhole equipment will be: (1) steam cleaned, (2) scrubbed with a brush and laboratory-grade detergent and water solution, and (3) rinsed with potable water before its use downhole and between holes. Some downhole geophysical probes may have restrictions pertaining to decontamination and will be decontaminated according to the manufacturer's specifications.

After cleaning and decontamination, all tools and equipment that may be used downhole must be kept clean and free of contaminants. Decontaminated equipment shall be kept off the ground by storing on clean racks and/or wrapping in plastic. All tools and equipment shall be cleaned and decontaminated as required to maintain an uncontaminated condition.

6.0 Restrictions/Limitations

Several hazards are associated with activities surrounding geophysical logging and these are outlined below:

6.1 Mechanical Hazards

The use of machinery to lift and lower the probe in and out of the borehole may require the use of hoists, cables, winches, rigs, etc., that are under tension or compression. Breakage or malfunction of any one of these components could cause the release of uncontrollable forces that may in turn impart tremendous physical damage to personnel and other equipment.

Site personnel shall be aware of swinging probes (weighing up to 136 kilograms [kg] [300 pounds]), or other associated equipment, suspended in midair before entry or after exiting the borehole. Site personnel shall also guard against falling components from probes that have had joints loosened.

6.2 Electrical Hazards

Hazards may arise from the use of several electrical power sources. Potential shocks may arise from improper handling of nongrounded power supplies or from probes using induced current electrodes or high voltage generators (120 to 600 V) used to power the tools. Lines from these power sources will be connected to ground fault circuit breakers.

All generators will be grounded. All extension cords from any power source will be composed of three conductor insulated wires and will be inspected for any frays, cuts, or other damage.

6.3 Nuclear Hazards

Many geophysical logging programs rely on a suite of techniques that are collectively classified as nuclear logging. Some nuclear logging tools contain radioactive materials that serve as sources of radiation that are uniquely attenuated by the surrounding borehole matrix. Other nuclear logging tools measure ambient gamma radiation and do not use radioactive sources but require frequent calibration with radioactive materials. All permits will be kept in an open file in the logging vehicle. The use of nuclear tools needs to be preplanned and carefully thought out, monitored, and well supervised by highly trained individuals familiar with the particular logging technique and equipment. Active nuclear logging tools will be stored in shields specifically designed for each tool (passive tools do not need shielding). Monitoring equipment must be used at specified times in nuclear tool storage facilities and will be calibrated at specified intervals. Tags indicating the dates of monitor equipment calibration will be attached. Wipe test results and calibration records will be stored onsite in open files.

For the health and safety of the staff engaged in geophysical logging, all personnel working with the geophysical team will wear a Thermoluminescent Dosimeter (TLD) badge or a Radiation Exposure Film Badge as required by project, client, and/or site requirements. This badge must be worn on the top front outer garment. Exception to this rule is given to visitors and temporary assistants, who must at all times maintain a safe distance (determined by the site safety officer) between themselves and the radioactive source(s).

A radiation survey meter will be available, checked, and calibrated for operation before site transport. An up-to-date copy of the radiation survey and meter calibration will be kept on file in the logging vehicle.

The following briefly summarizes the radioactive materials used for each logging technique:

- Natural gamma logging measures the ambient gamma radiation of in situ, naturally occurring elements within the geological strata such as potassium, thorium, and uranium. Tools used to detect natural gamma radiation do not emit radiation but are calibrated with radioactive material. Calibration standards requiring a license for purchase, handling, and transport will be used only by licensed and trained individuals.
- Neutron logging requires the use of radioactive sources that emit high-energy neutrons within the logging probe, some of which also emit gamma radiation. Neutron concentrations for these probes range between a low of 10 millicuries (mCi) to a high of 5 Curies (Ci). Radioactive sources commonly used in a neutron probe are americium/beryllium mixtures. Older probes may have mixtures of beryllium and radium or beryllium and plutonium. Radium/beryllium probes have an added danger over those made of americium/beryllium in that they emit high doses of gamma radiation. Because neutron radiation is most effectively attenuated by hydrogen atoms, shields for neutron sources are composed of hydrogenous materials. Storage facilities will be monitored to assure all shields are effectively blocking neutron radiation.
- Gamma-gamma and density logs contain radioactive sources that emit gamma radiation. The radioactive source most commonly used is cesium-137, with older probes using cobalt-60 as a gamma radiation source.

7.0 References

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8.0 Attachments

Attachment 1 - Example Health and Safety Checklist

Attachment 2 - Example QA Geophysical Checklist for Borehole Logging

Attachment 3 - Example Geophysical Logging Tool Checklist

Attachment 4 - Example Log Heading

Attachment 1
Example Health And Safety Checklist

Project Name/Contract Number _____

Well Name and Number _____ Location _____

Logging Company _____

Suite of Logs Run _____

Name of Recorder _____ Initials _____

Date and Time _____

General Health and Safety Checklist

Yes	No	
		All personnel working in the restricted area wearing TLD Badges or Radiation Exposure Film Badges as required?
		Restricted area properly controlled, thus preventing any unauthorized entry?
		All radioactive sources are stored in a secured, labeled, and properly shielded location?
		A copy of the operating and emergency procedures has been reviewed by logging supervisor and is on file in the field office?
		Were there any incidents that required implementation of emergency procedures? If yes, were the emergency procedures followed?
		Were storage facilities of radioactive sources posted with the proper labels?

Attachment 2
Example QA Geophysical Checklist For Borehole Logging

Project Name/Contract Number _____

Well Name and Number _____ Location _____

Logging Subcontractor _____ Date _____

Total Borehole Depth _____ (feet) Well Depth _____ (feet) Logger _____ (feet)

Ground Elevation _____ (feet) Permanent Datum _____

Permanent Datum Elevation _____ (feet)

Suite of logs to be run: Sp _____ Temp _____ "16-64" Ris _____ SPRis _____ Ind _____

Gam Ray _____ Gam Gam _____ Caliper _____ Other _____

Name of Operator: _____ Date: _____ Initials: _____

Name of Recorder: _____ Date: _____ Initials: _____

Monitor Well Construction Materials: Casing _____ Screen _____

Drilling/Construction Fluids: _____

General Quality Assurance Checks

Yes	No	
		Base map is located onsite.
		Before running the nuclear logging suite, borehole conditions were evaluated and considered suitable for such logs using information from caliper and previously run logs (e.g., depth, variations in diameter, lost circulation zones, casing, debris in hole, fluid type, and known contaminants)
		Appropriate scales have been chosen using nearby, onsite well logs. These are available for a comparison to present log readings.
		Onsite tool calibrations have been performed using calibration checks implemented before and after each log run.
		Logging scales chosen for all logging tools are appropriate for borehole conditions and required sensitivity. Off-scale logs have been rerun using scale adjustments when the offending off-scale run cannot generate an on-scale plot.
		Were there scale changes while running a log? If yes, which logs? _____
		Scale changes, exceptional conditions, and other anomalies have been appropriately annotated on the affected logs.
		Depth control during log mergings have been checked.
		After Survey Depth Errors (ASDE) have been checked.
		Hard copies have been examined for several log runs and there is good correlation of well depth between them.
		All well log hard copies have been examined upon completion of the logging suite and good correlation exists between them.
		Borehole mud samples have been taken just before logging and mud resistivity measured.
		Optimal data acquisition has been achieved by choosing the most appropriate logging speed and time constant from test runs (when necessary) of varying speeds.
		Logging speeds for boreholes less than 2,000 feet have not exceeded 25 feet per minute. Some tools may require slower logging speeds.
		Field log headings are filled out as completely as possible. Final print log headings are completely filled out.
		The repeat length for a uniform section has not been less than 50 feet, a variable section not less than 200 feet. When possible, boreholes less than 1,000 feet have had the entire hole length repeated.
		If log quality appears questionable, attempts have been made to ascertain cause and make adjustments. If a satisfactory log cannot be obtained, note reason.

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General Quality Assurance Checks (Cont.)

Yes	No	
		The specific hardware brand and model number used for data acquisition has been recorded in the field logbook. All software used for data acquisition and retrieval has been recorded in the field logbook.
		Tool manufacturer, model, and serial numbers have been noted. Tool configuration, diagrams, and manuals are available and located in the field (or logging) operation office.
		Logging subcontractor has been questioned to determine whether any tools have been modified or deviate from factory specifications. Modifications have been noted on field log checklist.
		CD ROMs have been made of the unedited, raw digital logging data and are stored in the field operation office.
		Processed, raw digital data that is in final form accompanies the final processing report.
		The final processing report has the necessary audit and audit process documentation.

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Temperature Log (This log shall be run first.)		
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
___ Tool logged in fluid-filled hole? (Yes/No) ___ Calibrated onsite (optional)? (Yes/No) If no, where calibrated and date of calibration? ___ Readings appear to be of good quality, no noise. (Yes/No) If noise exists, what is this attributed to?		

Spontaneous Potential (SP) Log		
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Tool logged in fluid-filled hole? (Yes/No) <input type="checkbox"/> Calibration performed before logging? (Yes/No) <input type="checkbox"/> Calibration performed after logging? (Yes/No) <input type="checkbox"/> Calibration data printed and attached to log trace. <input type="checkbox"/> Sensitivity for conditions appropriate? Line has "character." (Sensitivity sediment and fluid conditions may cause lack of character.) <input type="checkbox"/> No excessive SP baseline drift. <input type="checkbox"/> Baseline shifts (if necessary) annotated on log. <input type="checkbox"/> Resistivity of borehole fluid taken and recorded on log. <input type="checkbox"/> Resistivity of interstitial water taken and recorded on log.		

Project Name/Contract Number _____ Date _____

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location _____

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Attachment 3
Example Geophysical Logging Tool Checklist (Cont.)

Caliper (i.e., 1 arm, 3 arm?) Log		
Make	Model	Serial No.
Modification (Yes/No)?		(Describe fully on separate sheet and attach.)
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Calibration check performed <input type="checkbox"/> Caliper reading checked in casing, if casing is present <input type="checkbox"/> Repeat section logged or second run performed		

Gamma-Gamma (Density) Log		
Make	Model	Serial No.
Modification (Yes/No)?		(Describe fully on separate sheet and attach.)
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Hole condition good, checked by previous log runs (do not run nuclear tools under questionable hole conditions) <input type="checkbox"/> Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one) hole <input type="checkbox"/> Radiation survey conducted in immediate vicinity of drill site before unshielding source <input type="checkbox"/> Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded and logging job is finished <input type="checkbox"/> Calibration performed before logging <input type="checkbox"/> Calibration performed after logging <input type="checkbox"/> Calibration data printed and attached to log trace <input type="checkbox"/> Log checked for anomalous spikes, drift, and cyclic readings <input type="checkbox"/> Compare density log to caliper log; density shall show a variant reading in area of washouts <input type="checkbox"/> With probe sitting still, statistical variation shall be on the order of the square root of the count rate		

Project Name/Contract Number _____ Date _____

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location _____

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Attachment 3
Example Geophysical Logging Tool Checklist (Cont.)

Normal Resistivity	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Tool logged in fluid-filled hole, uncased hole <input type="checkbox"/> Calibration performed before logging <input type="checkbox"/> Calibration performed after logging <input type="checkbox"/> Calibration data printed and attached to log trace <input type="checkbox"/> Curve is stable, with no abnormal looking excursions		

Single Point Resistance		
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Tool logged in fluid-filled, uncased hole <input type="checkbox"/> Calibration performed before logging <input type="checkbox"/> Calibration performed after logging <input type="checkbox"/> Calibration data printed and attached to log trace <input type="checkbox"/> Resistance greater than cable line resistance <input type="checkbox"/> Scale reads in ohms <input type="checkbox"/> Check for sharp deflections of consistent amplitude and frequency caused by mechanical problems <input type="checkbox"/> Compare to caliper log. Is log greatly affected by change in borehole diameter?		

Project Name/Contract Number _____ Date _____

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location _____
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Attachment 3 Example Geophysical Logging Tool Checklist (Cont.)

Induction	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Tool logged in fluid-filled or air-filled (circle one), uncased hole <input type="checkbox"/> Calibration performed before logging <input type="checkbox"/> Calibration performed after logging <input type="checkbox"/> Calibration data printed and attached to log trace <input type="checkbox"/> Check for negative resistivity readings for indication of improper calibration <input type="checkbox"/> Check for similarity to 16" normal resistivity curve, for single curve, shallow investigation induction log <input type="checkbox"/> Repeat section logged		

Natural Gamma (Gamma Ray) Log		
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one) <input type="checkbox"/> Radiation survey conducted in immediate vicinity of drill site before unshielding source <input type="checkbox"/> Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded after job is finished <input type="checkbox"/> Hole condition is shielded after job is finished <input type="checkbox"/> Hole condition good, checked by previous log runs; do not run nuclear tools under questionable hole conditions <input type="checkbox"/> Tool run in fluid-filled or air-filled (circle one), uncased or cased (circle one) <input type="checkbox"/> Calibration performed before logging <input type="checkbox"/> Calibration performed after logging <input type="checkbox"/> Calibration data printed and attached to log trace <input type="checkbox"/> Check for cyclic noise <input type="checkbox"/> Repeat section logging		

Project Name/Contract Number _____ Date _____

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location _____

(Initial to certify this page)

Geophysical Logging, Calibration, and Quality Control

(Includes Potential Radioactive Sites)

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Revision: 5

Date: March 2007

Attachment 3 Example Geophysical Logging Tool Checklist (Cont.)

Neutron	Spacing between electrodes (inches)	
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Hole condition good, checked by previous log runs (do not run nuclear tools under questionable hole conditions) <input type="checkbox"/> Tool logged in fluid-filled or air-filled (circle one), uncased or cased (circle one) hole <input type="checkbox"/> Radiation survey conducted in immediate vicinity of drill site before unshielding source <input type="checkbox"/> Radiation survey conducted in immediate vicinity of drill site after last nuclear source is shielded after logging job is finished <input type="checkbox"/> Calibration performed before logging <input type="checkbox"/> Calibration performed after logging <input type="checkbox"/> Calibration data printed and attached to log trace <input type="checkbox"/> Check log for adequate sensitivity <input type="checkbox"/> Check log for anomalous spikes, drifts, and cyclic readings <input type="checkbox"/> Repeat section logged		

Acoustic Logs		
Make	Model	Serial No.
Modification (Yes/No)? (Describe fully on separate sheet and attach.)		
Tool schematic and operating manual on file (Yes/No)		Location of schematic
Order in which tool was run.	Run in combination with (other tools)	
Logging Speed (m/min) (ft/min)	Repeat Section Interval Location	
<input type="checkbox"/> Tool logged in fluid-filled, uncased hole (yes/no). If no, explain. <input type="checkbox"/> Calibration not required; check tool for function by listening for transmitter clicking; may calibrate tool in fluid-filled surface casing if present <input type="checkbox"/> Tool centralized <input type="checkbox"/> Log checked for noise spikes, cycle skipping, or other anomalies <input type="checkbox"/> Repeat section logged		

Project Name/Contract Number _____ Date _____

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location _____

(Initial to certify this page)

**Attachment 4
Example Log Heading**

Logging Subcontractor:			Log Technique:		
Address:			Date:		
Logging Operator:					
Drilling Subcontractor:					
Client:					
Well:					
Location:					
State:			Ground Elevation (m) (ft): Log Depth Ref:		
Borehole Data					
Logging Depth:					
Customer Measurement (m) (ft):			Logging Subcontractor Measurement (m) (ft):		
Bit Record			Casing Record		
Size	From	To	Size/Wgt/TLK	From	To
Hole Medium:				Drilling Method:	
Borehole Mud:				Circulation Time:	
Weight:		Viscosity:		Restrictions: mud formation at Temperature:	

Project Name/Contract Number _____ Date _____

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location _____

(Initial to certify this page)

Attachment 4
Example Log Heading (Cont.)

Logging Data						
Log Function	Run No.	Equipment			Logging	
		Model	Probe No.	Uphole S.N.	Dig Int (m/ft)	Speed (m/min)(ft/min)

Logging Data							
Detect OR	Spacing		Source		Logged Interval		
Type	Tx-Rx (m/ft)	Rx-Rx	Type	Curie Amount	From	To	Int. (m/ft)

Project Name/Contract Number _____ Date _____

Logging Subcontractor _____ Geophysical Logging Engineer _____ Well _____ Location _____

(Initial to certify this page)

TSOP 3-5
LITHOLOGIC LOGGING

Lithologic Logging

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Date: March 2007

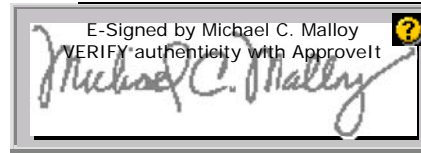
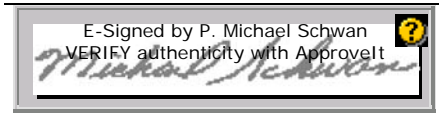
Prepared: Del R. Baird

Technical Review: John Hofer

QA Review: Jo Nell Mullins

Approved: _____

Issued: _____



Signature/Date

Signature/Date

1.0 Objective

This standard operating procedure (SOP) governs lithologic logging of core, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by CDM Federal Programs Corporation (CDM). The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used by all investigators in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

2.0 Background

2.1 Definitions

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the geologist in what to look for when following the sequences. Example lithologic logs are given in Attachment A.

Name of Sediment or Rock - In naming unconsolidated sediments, the logger shall use field equipment and reference charts to help identify the grain-size distribution and shall name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger shall examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

Texture - In examining unconsolidated sediments, the texture shall refer to the grain-size distribution, particle angularity, sorting, and packing. The logger shall provide estimates of the grain sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles shall be examined for angularity by comparing with Attachment B and the sorting shall be determined by percentage estimation. The logger shall note that the Unified Soil Classification System (USCS) uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliated structure (slaty, phyllitic, schistose, or gneissic) or nonfoliated structure (granular).

Color - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color shall be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names shall be listed, and an overall best color name shall be given.

Sedimentary Structures - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures, and the logger is referred to Compton's *Manual of Field Geology* (1962) book for more details. Among the more common structures are bedding, cross-bedding, laminations, and burrows. These structures shall only be included in the description if found in the samples.

Degree of Consolidation - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and shall

Lithologic Logging

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be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and shall be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials shall be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) shall be done and results recorded under the description. If the logger believes he/she can identify the cementing material, then it shall be included in the description.

Moisture Content - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and shall be described as dry, moist, wet (not flowing), or saturated (flowing water). Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks shall be noted.

Presence of Fractures, Cavities, and Secondary Mineralization - The rock that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they shall be noted and a description as to the density of fractures shall be given. Cavities or vugs may be present, and the density of voids, as well as size estimation, shall be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill shall be added.

Evidence of Contamination - The logger shall examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations shall be noted in the field book as shall any readings from the photoionization or flame ionization detector (PID/FID). PID/FID hits shall be recorded on the Lithologic Log Form also.

Description of Contacts - The logger shall note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts shall be noted as to whether they are erosional, gradational, or sharp, and the depth below the surface shall be noted.

Composition - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock shall be stated and an estimation of their percentage shall be noted. The classification charts listed in Attachments D and F provide a description of common compositions.

2.2 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist under a geologist's supervision, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks; grain-size percentage estimation; particle shape; grain-size charts; and lithologic symbols. To make lithologic descriptions produced by CDM staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

3.0 General Responsibilities

Geologist - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the field team leader (FTL).

Field Team Leader - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

4.0 Required Equipment

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log Form
- Clipboard
- Dilute (10 percent) HCl
- Plastic sheeting
- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts
- Engineers tape measure or folding stick

5.0 Procedures

5.1 Office

- Obtain field logbook and Lithologic Log Forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (i.e., hand lens, 10 percent HCl)
- Obtain CDM reference field charts
- Review field support documents (i.e., sampling plan, health and safety plan)
- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps

5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log Forms. Lithologic loggers will follow the general procedures for keeping a field logbook (SOP 4-1). When using a bound field logbook, record the same data required on the Lithologic Log Form. Data from the field logbook must be transcribed to the Lithologic Log Form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log Form, it shall be done within 1 day of the original data recording. All blanks in the Lithologic Log Form must be filled out. If an item is not applicable, an "NA" shall be entered. Note that the Lithologic Log may be modified based on the type of drilling (i.e., changing the blow count column to rock quality designation (RQD) for rock coring).

The Lithologic Log Form shall be filled out according to the following instructions:

The front page of the form contains general information:

- The project name, location, and description
- Borehole number
- Date that the drilling activity was started and completed
- Name of the person logging the well shall be recorded along with the total depth drilled
- Borehole diameter(s) and drilling methods shall be recorded
- Name and company of the driller and the type of drill rig and bits used

A map showing the drilling location may be attached.

The continuation page(s) shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and shall be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column shall contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes shall be recorded as to why the section was not recovered. The X shall be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a

solid horizontal line. Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits shall be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split-spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs shall ask the FTL whether it is required information. The description column is the most important part of the Lithologic Log Form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging shall determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger shall record the appropriate information into the logbook when there is a rig shutdown, rig problems, failures to recover cores, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This shall be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference.

General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions shall be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

Description detail will also be dependent on the drilling and sampling methods used. Descriptions of drill cuttings will generally be very basic verses detailed descriptions of soil split-spoon or rock core samples.

This SOP includes protocols for describing igneous, metamorphic, bedrock, sedimentary rocks, and unconsolidated materials. Common abbreviations used for lithologic logging purposes are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology and American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log Form or in the field logbook.
- The Munsell soil color chart may be used for descriptions of color.
- The *Dictionary of Geological Terms* (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions shall include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category shall be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All interpretive comments shall be segregated from lithologic descriptions by recording them in the remarks column.

Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation shall be described if observed. Exact measurement of apparent bed thicknesses shall be made when logging core and shall supplement terminology such as "thin" or "thick." Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible.

In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the USCS or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they shall do so with permission from the FTL.

It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed; however, the abbreviation and its meaning shall be recorded on the lithologic log the first time it is used and shall be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

5.2.1 Protocols for Lithologic Description of Discrete Soil or Rock Cores

This section describes the protocols for completing a lithologic description based on discrete soil or rock core samples. The logger shall use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core, it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the “big” picture. For instance, in a 20-foot-thick zone, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 below ground surface (bgs) = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in “seeing” the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

Description of Unconsolidated Material

Unconsolidated material comprises a significant portion of the sections of interest at CDM sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and shall use the same description format. The scientist shall use the USCS classification if consistent with project objectives (Attachment K). More detailed soil descriptions shall only be made in addition to descriptions outlined below.

Descriptions of unconsolidated sediments shall follow the following sequence:

- | | |
|---|---|
| ■ Name of sediment (sand, silt, clay, etc.) | ■ Degree of consolidation and cementation |
| ■ Texture | ■ Moisture content |
| ■ Composition of larger-grained sediments | ■ Evidence of bioturbation |
| ■ Color | ■ Description of contacts |
| ■ Structure | |

In naming unconsolidated material (refer to Attachment I - Naming of Unconsolidated Materials), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written:

_____ (dominant grain) with _____ (subordinate grain). For example, a sediment with 90 percent sand and 10 percent silt would be named a sand with silt. If a sediment contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt, and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt, and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage shall be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

Description of Bedrock Material

Descriptions of rock core can vary in detail depending on the experience of the geologist and the scope of the project. However, features that shall be noted while logging rock core include depth of major fractures, mineralization in fractures and cavities, degree of weathering, hardness, and RQD. The RQD is a ratio of the total length of intact rock 4 inches in length or longer to the length of the core run. The RQD provides a numeric indication of the degree of fracturing and weathering, and thereby, and indication of conductive zones and preferential contaminant migration pathways.

Description of Sedimentary Rocks

Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E - Classification of Sedimentary Rocks.

Descriptions for sedimentary rocks shall be given in the lithologic log in the following sequence:

- Name of rock
- Texture
- Color
- Bedding
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Bioturbation
- Description of contacts

Description of Igneous and Metamorphic Rocks

Igneous and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments D and F provide a classification system for these materials.

Igneous and metamorphic rock descriptions shall follow the general format:

- Name of rock
- Texture
- Color
- Degree of induration for volcanics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization
- Foliation

5.2.2 Protocols for Lithologic Description from Drill Cuttings

The majority of boreholes drilled in bedrock are drilled without sampling or coring. This section describes the protocols that may be used for completing lithologic logs when discrete soil samples or rock cores are not collected. Lithologic logging of boreholes drilled without sampling generally requires a higher level of experience from the geologist as interpretations need to be made based on a number of factors that are usually not taken into account when logging from discrete samples. Certain details recorded on lithologic logs based on discrete sampling will not be seen (such as sedimentary structures) and therefore cannot be recorded from drill cuttings. Below are general guidelines that shall be used while filling out boring logs based on drill cuttings:

Auger Drilling

The following are general guidelines that can be used to describe cuttings from auger drilling:

- Collect cuttings for descriptions at least every 5 feet or if a change in the cuttings is noticed.
- Keep in mind travel time for cuttings to reach the surface when estimating the depth from which the cuttings originated.
- Pay attention to the reaction of the drill rig as different lithologies are encountered such as chattering versus smooth drilling, rapid easy auger advancement versus slow hard drilling, and auger refusal.
- Watch for the occurrence of water.

Bedrock Rotary Drilling (including air hammer, air rotary, and mud rotary)

The following are general guidelines that shall be used during rotary drilling:

- Use a strainer to collect cuttings at intervals of at least 10 feet or changes in lithology.
- Wash the cuttings in the strainer with potable water and examine for lithology.
- Note size of rock chips.
- Note changes in drill rig responses such as increasing or slowing drilling rate, sudden drop of the drill stem, increase in chatter and record in the remarks column of the lithologic log. These are usually good indicators of changes in lithology and/or fractures.
- If drilling with air, look for changes in color and reduction or disappearance of dust as an indicator of a lithology change and/or presence of water.
- If drilling with mud/fluid rotary, watch for gain or loss of water as an indicator of conductive zones.
- Record drilling rates as feet/minute, or as start and end times of each drill rod, in the remarks column of the boring log.

6.0 Restrictions/Limitations

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 References

American Geological Society. 1989. *American Geological Society Data Sheets for Geology in the Field*, Laboratory, and Office, 3rd Ed.

Compton, R.R. 1962. *Manual of Field Geology*, John Wiley & Sons Inc., New York, New York.

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_____. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites, EM 1110-1-4000*, Chapter 4. November 1.

U. S. Department of Agriculture Soil Conservation Service. 1972. *Soil Taxonomy*, U. S. Government Printing Office, Washington, D.C.

Woodward, L.A. 1988. *Laboratory Manual Physical Geology*, University of New Mexico Printing. Albuquerque, New Mexico.

8.0 Attachments

Note: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - CDM Federal Programs Corporation Lithologic Logs

Attachment B - Grain-Size Scale; Graph determining size of sedimentary particles, particle degree of roundness charts

Attachment C - Comparison Chart for Estimating Percentage Composition

Attachment D - Classification of Igneous Rocks

Attachment E - Classification of Sedimentary Rocks

Attachment F - Classification of Metamorphic Rocks

Attachment G - Lithologic Symbol Chart

Attachment H - Common Abbreviations for Lithologic Logging

Attachment I - Naming of Unconsolidated Materials

Attachment J - Sorting Chart

Attachment K - Example of Unified Soil Classification System (USCS)

Attachment A

CDM Federal Programs Lithologic Logs

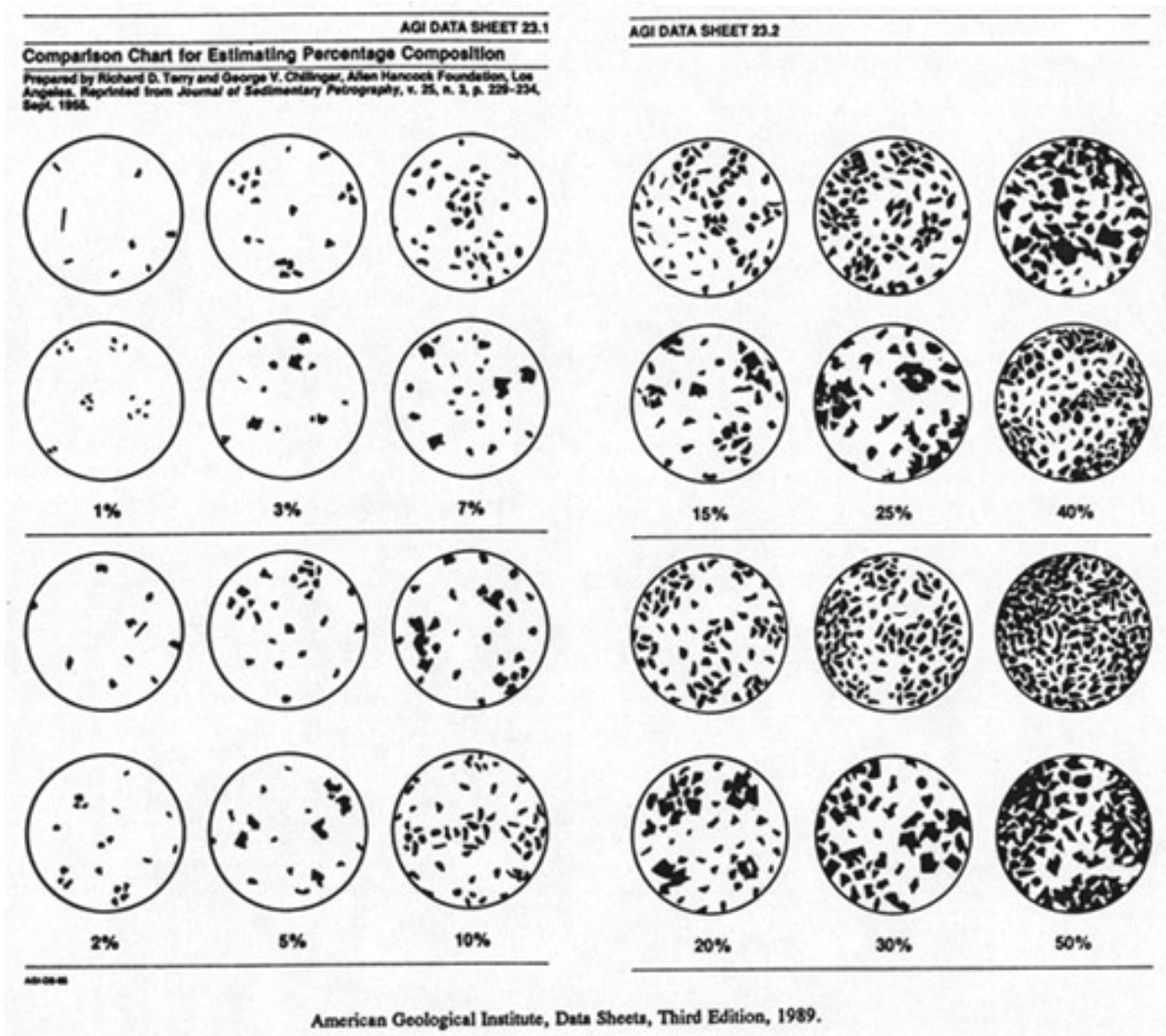
Grain-Size Scale; Graph determining size of particles, particle degree of roundness charts

Figure 1 displays six columns of particle images, each showing two representative particles. The columns are labeled from left to right: 'Very angular', 'Angular', 'Sub-angular', 'Sub-rounded', 'Rounded', and 'Well rounded'. The particles transition from highly irregular, sharp-edged shapes to smooth, spherical or oval shapes.

CDM Technical Standard Operating Procedures
TSOP 3-5 33007

Attachment C

Comparison Chart for Estimating Percentage Composition



Attachment D

Classification of Igneous Rocks

Classification of Igneous Rocks					
Mineral Composition					
		Quartz >10% Abundant feldspar Mafic minerals minor	Quartz <10% Abundant feldspar Mafic minerals moderate	Feldspar abundant Mafic Minerals 40-70%; Quartz minor or absent	Mafic minerals >70%
Color Index		Light Color	Intermediate color	Dark	Dark
Chemistry		SiO ₂ 70%	SiO ₂ 60%	SiO ₂ 50%	SiO ₂ 40%
	Phaneritic (visible with naked eye)	Granite (Gr)	Diorite (Dr)	Gabbro (Gb)	Peridotite (Pr) (mostly olivine)
TEXTURE	Aphanitic (microscopic)	Rhyolite (Ry) (quartz phenocrysts)	Andesite (An) (feldspar or mafic phenocrysts; no quartz)	Basalt (Ba)	Komatiite (Km) (very rare)
		Felsite (Fl) (no phenocrysts)			
	Glassy	Obsidian (ob) Pumice (Pu)		Rare	
	Glassy-Fragmental (Pyroclastic)	Tuff <4mm (Tf) Breccia >4mm (Br)		Rare	

Attachment E

Classification of Sedimentary Rocks

Classification of Sedimentary Rocks				
<i>Detrital</i>	<i>Detrital Classification</i>	<i>Principal Composition</i>	<i>Additional Identifying Characteristics</i>	<i>Name of Rock</i>
	Rudaceous (clast diameter > 2 mm)	Gravel	Rounded Clasts	Conglomerate (Cg)
			Angular Clasts	Breccia (Br)
	Arenaceous (clast diameter between 0.0625 mm [1/16 mm] and 2 mm)	Sand	Mineral composition and detrital matrix content varies. Additional detrital matrix qualifiers (arenite or wacke) and mineral composition qualifiers (quartz, arkose, feldspathic, etc.) may be necessary.	Sandstone (Sa)
	Argillaceous (clast diameter <0.0625 mm)	Mud	Non-fissile along bedding planes, silt predominant over clay	Siltstone (Sl)
			Non-fissile along bedding planes, clay predominant over silt	Claystone
			Non-fissile along bedding planes, silt and clay fraction approximately equal or unknown	Mudstone (Ms)
			Fissile along bedding planes	Shale (Sh)
<i>Chemical</i>	<i>Chemical Classification</i>	<i>Principal Composition</i>	<i>Additional Identifying Characteristics</i>	<i>Name of Rock</i>
	Calcareous	Calcite (Calcium Carbonate)	Effervesces on contact with dilute HCl	Limestone (La)
		Dolomite (Calcium Magnesium Carbonate)	Pulverized sample effervesces on contact with dilute HCL	Dolomite (Dl), Dolostone
	Siliceous	Quartz (Silicon Dioxide)	Hard, dense, fractures conchoidally	Chert (Ch)
	Evaporites	Hydrated Calcium Sulfate	Earthy and crumbly	Gypsum (Gy)
		Calcium Sulfate	Usually exhibits indistinct stratification	Anhydrite
		Halite (Sodium Chloride)	Cubic cleavage	Rock Salt (Na)
<i>Organic (Organogenetic or Biochemical)</i>	<i>Chemical Classification</i>	<i>Principal Composition</i>	<i>Additional Identifying Characteristics</i>	<i>Name of Rock</i>
	Calcareous	Fossil shells and fragments	Loosely cemented fragmental limestone	Coquina (Cq)
		Foraminiferal shells	Soft, micritic limestone	Chalk (Chk)
		Calcite or aragonite	Derived from evaporation of spring water	Travertine (Tvr)
	Siliceous	Diatom shells (saltwater or freshwater organisms)	Light-colored, soft, friable, and porous siliceous deposit	Diatomite (Dm)
	Carbonaceous	Plant Remains	Degree of lithification varies-additional qualifiers such as peat, lignite, bituminous and anthracite may be necessary.	Coal (Cl)

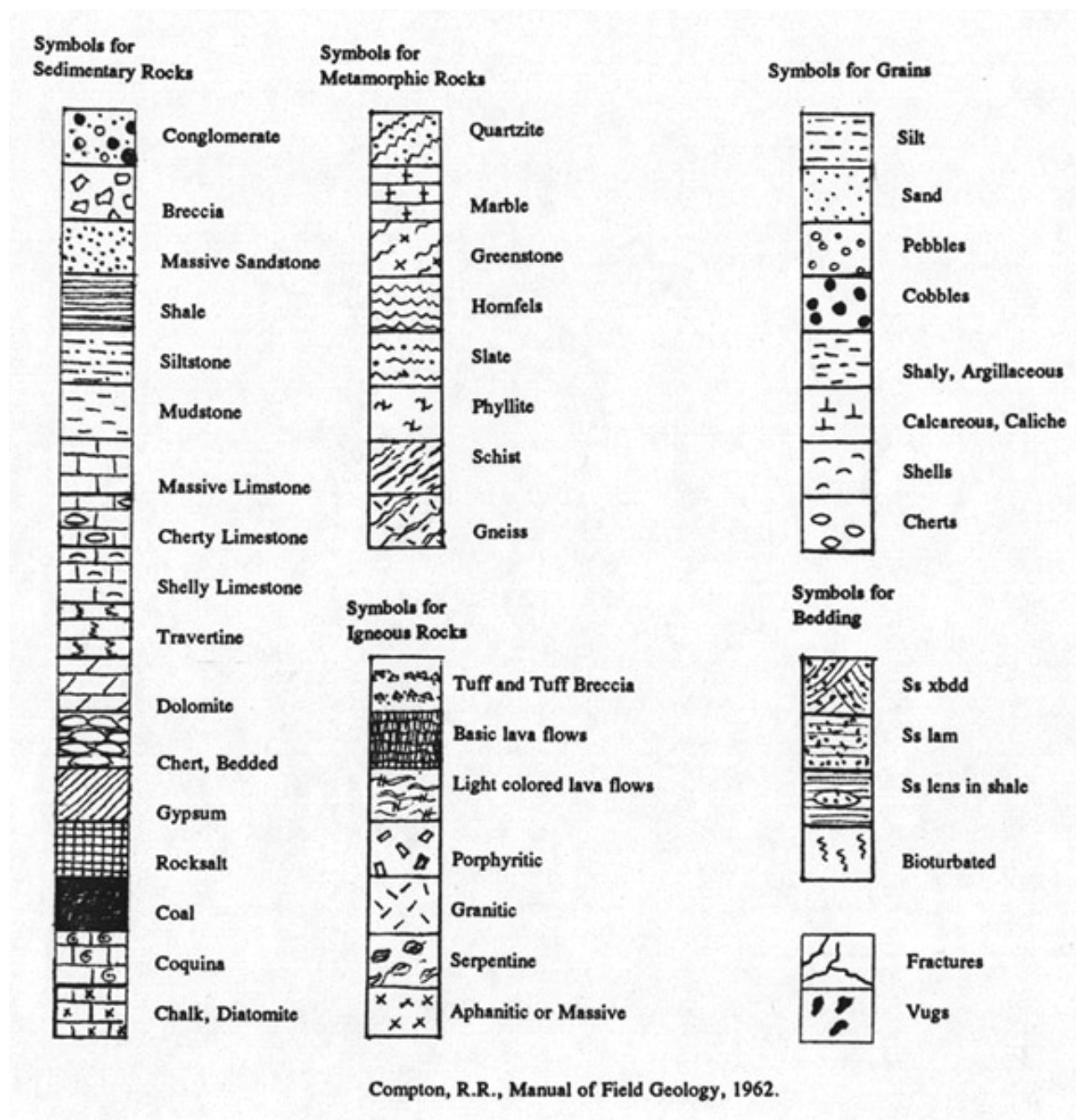
Attachment F

Classification of Metamorphic Rocks

Classification of Metamorphic Rocks			
Structure	Texture	Chief Minerals	Name
Non foliate	granular; breaks across grains	quartz	Quartzite (Qzt)
	granular; grains clearly visible	calcite	Marble (Mbl)
	granular; grains altered and indistinct	plagioclase, chlorite, epidote hornblende	Greenstone (Grs)
	very fine-grained	indistinguishable; mostly submicroscopic micas and clays	Hornfels (Hnf)
Foliate	slaty	submicroscopic mica, quartz	Slate (Slit)
	phyllitic	microscopic mica, quartz	Phyllite (Pyl)
	schistose	microscopic mica, quartz, amphibole	Blueschist
		chlorite, mica plagioclase	chlorite schist (CL-Sch)
		muscovite, quartz	Muscovite (Ms) Schist (Sch)
		garnet, muscovite	Garnet (G) Muscovite (Ms) Schist (Sch)
		hornblende, plagioclase	Amphibolite (Amp)
		staurolite, garnet, muscovite	Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)
		plagioclase, hornblende	Amphibolite (Amp) Gneiss (Gns)
	gneissose	feldspar, quartz	Granite (Gr) Gneiss (Gns)
		eye-shaped feldspar, mica	Augen (Au) Gneiss (Gns)

Attachment G

Lithologic Symbol Chart



Attachment H

Common Abbreviations for Lithologic Logging

Common Abbreviations		
Abundant – abnt	Diameter – dia	Laminated – lam
Amount – amt	Different – diff	Maximum – max
Approximate – approx	Disseminated – dissem	Pebble – pbl
Arenaceous – aren	Elevation – elev	Phenocryst – phen
Argillaceous – arg	Equivalent – equiv	Porphyritic – proph
Average – ave	foliated – fol	Probable – prob
Bedded – bdd	Formation frm	Quartz – qrz
Bedding – bdg	Fracture – frac	Regular – reg
Calcareous – calc	Fragmental – frag	Rocks – rx
Cemented – cmt	Granular – Gran	Rounded – rnd
Cobble – cbl	Gypsiferous – Gyp	Saturated – sat
Contact – ctc	Horizontal – hriz	Secondary – sec
Cross-bedded - xbdd	Igneous – ign	Siliceous – sil
Cross-bedding – xbdg	Inclusion – incl	Structure – struc
Cross-laminated – xlam	Interbedded – intbdd	Unconformity – uncnf
Crystal – xl	Irregular – ireg	Variegated – vrgt
Crystalline – xln	Joint – jnt	Vein – vn
Grain Size	Contacts	Sorting
grain – gn	gradational – grad	poor – pr
fine – f	erosional – er	moderate – mod
very fine – vf	abrupt – ab	well – well
medium – med		
coarse – crs	Fabric	
large – lg	grain supported – gs	
very large – vlg	matrix supported – ms	
small – sm	imbricate – im	

Adapted from, Compton, R.R., *Manual of Field Geology*, 1962.

Attachment I

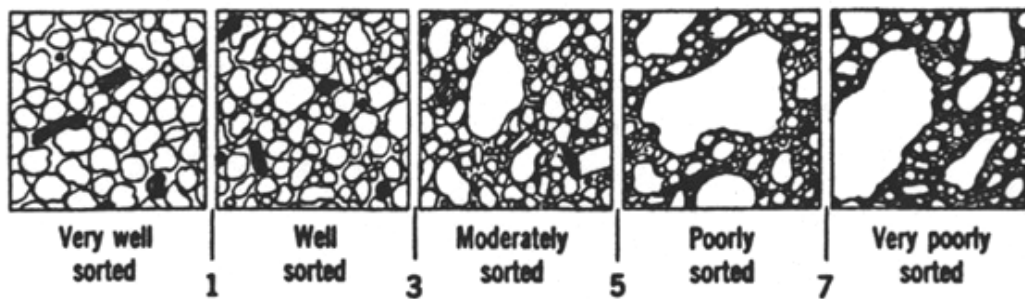
Naming of Unconsolidated Materials

Main Particle	Gravel	Sand	Silt	Clay
> 15 % gravel	Gravel	Gravelly Sand	Gravelly Silt	Gravelly Clay
> 15 % sand	Sandy Gravel	Sand	Sandy Silt	Sandy clay
> 15 % silt	Silty Gravel	Silty Sand	Silt	Silty Clay
> 15 % clay	Clayey Gravel	Clayey Sand	Clayey Silt	Clay
5-15 % gravel	Not Applicable	Sand with Gravel	Silt with Gravel	Clay with Gravel
5-15 % sand	Gravel with sand	Not applicable	Silt with Sand	Clay with sand
5-15 % silt	Gravel with silt	Sand with silt	Not applicable	Clay with silt
5-15 % clay	Gravel with clay	Sand with clay	Silt with clay	Not applicable
> 15% gravel plus 15% sand	Sandy Gravel	Gravelly Sand	Gravelly Sandy Silt	Gravelly Sandy Clay
> 15% gravel plus 15% silt	Silty Gravel	Gravelly Silty Sand	Gravelly Silt	Gravelly Silty Clay
> 15% gravel plus 15% clay	Clayey Gravel	Gravelly Clayey Sand	Gravelly Sandy Silt	Gravelly Clay
> 15% sand plus 15% silt	Silty Sand Gravel	Silty Sand	Sandy Silt	Sandy Silty Clay
> 15% sand plus 15% clay	Sandy Clayey Gravel	Clayey Sand	Sandy Clayey Silt	Sandy Clay
> 15% silt plus 15% clay	Silty Clayey Gravel	Silty Clayey Sand	Clayey Silt	Silty Clay
Note: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt.				

Compton, R.R., *Manual of Field Geology*, 1962.

Attachment J





Sorting Chart



Compton, R.R., Manual of Field Geology, 1962.

Attachment K

Example of Unified Soil Classification System (USCS)

Unified Soil Classification System (USCS)			
	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL:			
COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND:			
COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10 
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40 
FINE	.43 - .08	.02 - .003	No. 40 - No. 200 
FINES:			
SILTS	< .08	< .003	< No. 200 
CLAYS	< .08	< .003	< No. 200

Attachment K

Example of Unified Soil Classification System (USCS)
(Continued)

C L A Y

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF)	Unconfined Compressive Strength q_u
			TORVANE	Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4" by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

S A N D

SOILTYPE	SPT, N Blows/ft.	Relative Density, %	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

Example of Unified Soil Classification System (USCS)
(Continued)

Summary of USCS Field Identification Tests

Coarse-Grained Soils More than half the material (by weight) is individual grains visible to the naked eye	Gravelly Soils More than half of coarse fraction is larger than 4.75 mm		Clean Gravels Will not leave a stain on a wet palm	Substantial amounts of all grain particle sizes			GW
				Predominantly one size or range of sizes with some intermediate sizes missing			GP
	Sandy Soils More than half of coarse fraction is smaller than 4.75 mm		Dirty Gravels Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)			GM
				Plastic fines (to identify, see CL below)			GC
			Clean Sands Will not leave a stain on a wet palm	Wide range in grain size and substantial amounts of all grain particle sizes.			SW
				Predominantly one size or a range of sizes with some intermediate sizes missing			SP
Fine-Grained Soils More than half the material (by weight) is individual grains not visible to the naked eye (<0.074 mm)	Dry Crushing Strength		Dilatancy Reaction	Toughness	Stickiness		
		Ribbon	Liquid Limit				
	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
	Very Strong	>50	High to Very High	None	High	Very High	CH
Highly Organic Soils	Readily identified by color, odor, spongy feel, and frequently by fibrous texture						OL OH Pt

TSOP 3-6
UNDERGROUND FACILITY LOCATION

Underground Facility Location*

**Applicable only if CDM, its subcontractor, or lower-tier subcontractor performs the intrusive work. Consult with responsible party for all other situations.*

SOP 3-6

Revision: 0

Date: May 6, 2005

Prepared: Joe Mayo

Technical Review: Sharon Budney

QA Review: Doug Updike

Approved:  5/5/06

Issued:  5/5/05

Signature/Date

Signature/Date

1.0 Objective

The objective of this procedure is to provide background information, resources, and guidance for locating underground facilities prior to performing excavations or other intrusive activities such as soil boring or demolition activities.

2.0 Background

To protect the public health and avoid serious and costly accidents that occur each year due to damage to underground utilities from excavation and other intrusive activities, most states have enacted laws and promulgated regulations that require notification and markout of underground utilities prior to performing excavation or other intrusive activities. These laws also require underground facility owners and operators to locate, markout, or otherwise provide the location of underground facilities that they operate so that contractors and others performing intrusive activities can take reasonable care to avoid damaging the facilities.

All states, and in some cases, localities within states, have established "one-call" type systems to facilitate location of underground facilities. These systems typically are operated by independent entities that are funded by the underground facility operators. They provide communication and verification services for locating underground facilities. One-call system operators are responsible for contacting the appropriate underground facility owners, ordering markouts, and tracking markout orders. The one-call system operator maintains records of requests for markouts and also maintains contact information for the field supervisor or other responsible person who requested the markout. This simplifies the process for contractors and allows them to take reasonable care to avoid accidental damage to underground utilities.

Most state laws require contractors to contact the one-call system prior to performing intrusive activities. The contractor (CDM) must provide information including the site location (in some cases, the boundary of the excavation must be marked out), proposed start date, depth of the excavation, and contact information for a representative of the contractor, etc. Most laws provide for civil penalties for violation of the law and some provide for criminal penalties for negligence if an underground facility is damaged and the one-call system was not contacted.

Each state law is different, and it is the responsibility of the contractor to understand the law and activate the state's one-call system. Most states maintain web sites that provide one-call system information and offer downloadable forms for requesting subsurface facility markouts. Many of the one-call web sites also provide state regulations, procedures for using the system, procedures to follow if an underground facility is struck, and other important information. A list of telephone numbers to activate the one-call system in various states and localities is provided in Attachment A.

Often responsibility for contacting the one-call system and confirming the markout is transferred, by contract, to the subcontractor performing the intrusive work (i.e., driller, excavator, etc.). It is important to take reasonable care to ensure that the subcontractor has contacted the one-call system, that the markout has been completed, and that it includes the area where the intrusive activity will occur. No work should occur until the site manager or field manager is confident that the subcontractor has met their responsibility as defined in the subcontract statement of work.

Using a one-call system is not a guarantee that all underground facilities in an area have been identified. Not all facility operators participate in the one-call system or they may be exempt from participation by law. The one-call system operator can provide information on participating operators. Operators of exempted or nonparticipating underground facilities must be contacted directly to determine the location of their facilities. Responsibility for contacting these operators and locating the underground facilities may be transferred to a subcontractor via the subcontract statement of work. If responsibility is not transferred to a subcontractor, then it is the responsibility of the CDM site manager or designee to contact the facility operator and determine the location of the underground facility.

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2.1 Definitions

Excavation - State laws often define this term broadly to mean any movement of any earthen materials or rock, especially by means of machinery or explosives. Excavations below minimum depths (e.g., 12 inches) may trigger activation of the one-call system. For example, New Jersey's Underground Facility Protection Act defines excavation as:

"...any operation in which earth, rock, or other material in the ground is moved, removed, or otherwise displaced by means of any tools, equipment, or explosive, and includes but is not limited to drilling, grading, boring, milling, to a depth greater than six inches, trenching, tunneling, scraping, tree and root removal, cable or pipe plowing, fence post or pile driving, and wrecking, razing, rending, or removing any structure or mass material, but does not include routine residential property or right of way landscaping activities performed with non-mechanized equipment, excavation within the flexible or rigid pavement box within the right-of-way, or the tilling of soil for agricultural purposes to a depth of 18 inches or less."

One-Call Operator - The person identified by the one-call system as the point of contact for location of underground facilities. The one-call operator is responsible for obtaining excavation location information from the excavator, contacting facility operators, ordering the markout, and providing verification that the markout has been completed.

One-Call System - Any of a number of communication systems established by state or local law to provide underground facility markout services to protect underground facilities. There are a number of state and regional one-call systems such as Dig Safe, Call Before You Dig, One Call, Miss Utility, and others.

Underground Facilities - Typically public or private facilities that are buried below ground or submerged on public or private property and used to convey water, sewage, telecommunications, cable television, electricity, oil, petroleum, gas, optical signals, or traffic control. Be aware that some regulations may exclude certain facilities such as storm drains and gravity sewers.

Operator - Person or entity that owns or operates an underground facility as defined above. One-call laws generally require operators to provide the location of their facilities and to perform the markout. Homeowners who operate underground facilities, such as lawn sprinklers, are usually not considered to be operators.

Waiting Period - Most one-call systems establish a minimum time to allow the markout to be completed before excavation activities can proceed. Lead times vary by state but usually are 2 to 3 business days.

Expiration Date - Some states require that the excavation activities must begin within a certain time period after the markout is completed or after the one-call system is contacted. If work is delayed, check with the one-call system to ensure that the markout remains valid.

2.2 Discussion

Excavation Activities on Residential Properties - Underground facility markouts often do not extend onto residential properties. Markouts usually show residential connections at the boundaries of the property, but end there. Excavation activities planned on residential properties require the use of other methods to determine the location of underground utilities such as water lines, electrical lines, septic systems, leach fields, and sewer lines. In addition, homeowners may install other underground facilities such as water sprinkler systems, low voltage lighting lines, well piping, and swimming pool plumbing.

The planning process for conducting work on residential properties must consider the activities that will be performed and their locations relative to the building footprint. Information about the location of underground utilities may be obtained from the residents before performing intrusive activities, but this information is often uncertain. Procurement of a geophysical subcontractor experienced in locating underground utilities is often the best choice to avoid damage to residential underground facilities. The responsibilities of the subcontractor for locating underground facilities should be clearly defined in the subcontract statement of work. Additional methods for avoiding utilities include hand digging and use of a vacuum system to remove soil from the excavation.

Underground Facility Location*

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Use of an Underground Facility Location Subcontractor - In some situations or in particular areas of the country, it is customary to procure the services of a subcontractor experienced with providing utility markout services. This may be particularly useful for sites that cover large areas and require numerous markouts or in certain areas of the country where these services are used to identify underground facilities. For example, in some western states, the one-call systems are operated at the county or regional level and may require more coordination activities. The subcontractor must comply with all state and local regulations including activation of the one-call system. When this option is selected to identify underground facilities, the procedures described below for subcontractor as the excavator should be followed. The responsibilities of the subcontractor for locating underground facilities should be clearly defined in the subcontract statement of work.

2.3 Associated Procedures

- CDM Federal (CDM) SOP 1-4, *Subsurface Soil Sampling*
- CDM SOP 3-1, *Geoprobe® Sampling*
- CDM SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*

3.0 Responsibilities

Project Manager - The project manager is responsible for ensuring that underground facility location responsibilities are clearly stated in subcontractor statements of work, as applicable.

Site Manager - The site manager is responsible for ensuring that the subcontractor has met their facility location responsibility as defined in the subcontract statement of work. If the underground facility location responsibility is not transferred to a subcontractor, it is the responsibility of the site manager to contact one-call and facility operators to determine locations.

Field Manager - The field manager is responsible for ensuring that work is not initiated until they are confident that underground facility location has occurred in the area of the work.

4.0 Procedures

General Procedures to Ensure that Underground Facilities are Identified Before Excavation

Note: The terms 'excavator' and 'excavation' used in the following procedures are broadly defined to include a variety of intrusive activities including excavation, soil boring, well drilling, test excavations, etc.

Subcontractor as the Excavator - Frequently CDM transfers the responsibility for contacting the appropriate one-call system, via the subcontract statement of work, to a subcontractor such as an excavator or driller. The procedures below apply to the location of underground facilities, when a subcontractor is responsible for contacting the one-call system, and identifying underground facilities.

- Clearly define the subcontractor's responsibility in locating underground facilities in the subcontract statement of work.
- Obtain and be aware of the state or local regulations concerning excavation activities and underground facilities (contact the one-call system's website or call the system operator).
- Define areas for excavation. Be as specific as possible with the location and include address, block and lot, milepost markers, cross streets, drawings, etc. (**Note** - State law may require that the proposed excavation area be physically delineated before the markout. Also be aware that methods for identifying locations vary from state to state).
- Provide the locations of the proposed excavations/borings to the subcontractor.
- Before beginning work, verify that the subcontractor has contacted the one-call system and that the required markouts have been completed. Obtain confirmation numbers or other documentation to verify that the subcontractor has

Underground Facility Location*

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contacted the one-call system or underground facility operator and that the markout has been completed. Obtain a list of the utilities that were contacted. Record all conversations with the subcontractor related to underground utility location in the field logbook.

- Before beginning the excavation activities, ensure that the appropriate area has been marked out and that the required waiting period has elapsed. Also, ensure that a delay in the start of the excavation activity has not invalidated the markout. If in doubt, contact the one-call system.
- Perform a walkover and visual inspection of the markout area. Verify that the markout area covers the proposed excavation area. If any of the markouts are unclear or do not cover the excavation area, notify the subcontractor that the markout is not adequate. Request an additional markout if necessary.
- During the visual inspection, note the locations of features that may indicate underground facilities (manholes, sewer grates, vent pipes, electrical boxes, etc.). Depending on the state, not all utilities may be marked out (e.g., gravity sewers are excluded from New Jersey's underground facility protection law). Some facility operators may not have the resources to participate in the one-call system. The local municipality or utility must be contacted to determine the location of these underground facilities.
- Begin excavation activities. Be cautious during the initial stages of the intrusive activity. Be alert for signs that an underground facility may be present. Look for changes in the soil characteristics such as the presence of fill materials or non-native materials. Be alert for visual and aural cues that may indicate the presence of underground facilities (metallic sounds, changes in drilling progress, etc.).
- If an underground facility is struck or breeched, cease operations immediately. Remove all personnel from the area, inform the subcontractor, contact the facility operator, inform your supervisor, and follow the emergency procedures in the site-specific health and safety plan. The subcontractor should immediately contact the one-call system and identify the problem.

Note: If CDM takes an active role in contacting the one-call system, utility companies, or other operators of underground facilities, it may relieve the subcontractor of responsibility for locating the underground utilities. Before beginning intrusive activities, the site manager and subcontract manager should be consulted if it is believed that the subcontractor has not fulfilled his responsibility under the subcontract.

CDM as the Excavator - The procedures below define reasonable steps to be taken to avoid damage to underground facilities when CDM is the excavator. In most cases it is advisable to designate a subcontractor (via contract) as the party responsible for location of underground facilities.

- Obtain and be aware of the state or local regulations concerning excavation activities and underground facilities.
- Obtain a copy of the appropriate one-call system underground facility location request form to determine what information is required to submit an underground facility location request.
- Define areas for excavation. Be as specific as possible with the location and include address, lot and block, milepost markers, cross streets, drawings, etc. (**Note** - State law may require that the proposed excavation area be physically delineated before the markout).
- Contact the appropriate one-call system and provide information on the location of the proposed excavation and field manager or site manager contact information (provide the specific information required by the state's one-call system request form).
- Obtain a confirmation number or other documentation to verify that the markout has been completed. Obtain a list of the utilities that were contacted by the one-call system operator. Record all conversations with the one-call operator of underground utility operator in the field logbook.

Underground Facility Location*

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- Before beginning the excavation activities, ensure that the appropriate area has been marked out and that the required waiting period has elapsed. Also, ensure that a delay in the start of the excavation activity has not invalidated the markout. If in doubt, contact the one-call system.
- Perform a walkover and visual inspection of the markout area. Note the location of the marked out underground facilities and the proposed excavation location(s). If any of the markouts are unclear or do not cover the excavation area, contact the one-call system. Also during the visual inspection, note the locations of features that may indicate underground facilities (manholes, sewer grates, vent pipes, electrical boxes, etc.). Depending on the state, not all utilities may be marked out (e.g., gravity sewers are excluded from New Jersey's underground facility protection law). Other facility operators may not have the resources to participate in the one-call system. The local municipality or utility must be contacted to determine the location of these underground facilities.
- Determine what clearances are required between the location of the underground facility and the proposed excavation (clearances vary by state).
- Measure distance between proposed excavation and underground facility to ensure that proper clearance distance is maintained.
- Begin excavation activities. Be cautious during the initial stages of the excavation activity. Be alert for signs that an underground facility may be present. Look for changes in the soil characteristics such as the presence of fill materials or non-native materials. Be alert for visual and aural cues that may indicate the presence of an underground facility (metallic sounds, changes in drilling progress, etc.).
- If an underground facility is struck or breached, cease operations immediately. Remove all personnel from the area, contact the one-call system, inform your supervisor, contact the facility operator, and follow the emergency procedures in the site-specific health and safety plan.

5.0 References

New Jersey Statute, Title 48. 1997. Public Utilities, Chapter 2. Board of Public Utility Commissioners, Article 9. Underground Facility Protection.

New York State Department of Public Service, Safety Section, New York Department of Public Service, Rule 753. *Duties of Excavators*, Sections 753-3.2 - 753-3.17.

Dig Safe, Inc. website, www.digsafe.com.

New Jersey One Call website, www.nj1-call.org.

New York State Electric and Gas (NYSEG) website, safety section, www.nyseg.org.

Dig Safely website, links to state laws and one-call contacts, www.digsafely.com.

TSOP 4-1

FIELD LOGBOOK CONTENT AND CONTROL

Field Logbook Content and Control

SOP 4-1
Revision: 6
Date: March 2007

Prepared: Del Baird

Technical Review: Laura Splichal

QA Review: Jo Nell Mullins

Approved: 

Issued: 
Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to set CDM Federal (CDM) criteria for content entry and form of field logbooks. Field logbooks are an essential tool to document field activities for historical and legal purposes.

2.0 Background

2.1 Definitions

Biota - The flora and fauna of a region.

Magnetic Declination Corrections - Compass adjustments to correct for the angle between magnetic north and geographical meridians.

2.2 Discussion

Information recorded in field logbooks includes field team names; observations; data; calculations; date/time; weather; and description of the data collection activity, methods, instruments, and results. Additionally, the logbook may contain deviations from plans and descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 General Responsibilities

Field Team Leader (FTL) - The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure.

Site Personnel - All CDM employees who make entries in field logbooks during onsite activities are required to read this procedure before engaging in this activity. The FTL will assign field logbooks to site personnel who will be responsible for their care and maintenance. Site personnel will return field logbooks to the records file at the end of the assignment.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities should be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Site-specific plans
- Indelible black or blue ink pen
- Field logbook
- Ruler or similar scale

5.0 Procedures

5.1 Preparation

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office or vehicle for easy reference.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered before initial use of the logbook. Before use in the field, each logbook will be marked with a specific document control number issued by

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the document control administrator, if required by the contract quality implementation plan (QIP). Not all contracts require document control numbers. The following information shall be recorded on the cover of the logbook:

- Field logbook document control number (if applicable).
- Activity (if the logbook is to be activity-specific), site name, and location.
- Name of CDM contact and phone number(s) (typically the project manager).
- Start date of entries.
- End date of entries.
- In specific cases, special logbooks may be required (e.g., waterproof paper for stormwater monitoring).

The first few (approximately five) pages of the logbook will be reserved for a table of contents (TOC). Mark the first page with the heading and enter the following:

Table of Contents

Date/Description (Start Date)/Reserved for TOC	Pages 1-5
---	--------------

The remaining pages of the table of contents will be designated as such with "TOC" written on the top center of each page. The table of contents should be completed as activities are completed and before placing the logbook in the records file.

5.2 Operation

Requirements that must be followed when using a logbook:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information does not need to be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the logbook by inserting the following:
Above notes authored by:
 - (Sign name)
 - (Print name)
 - (Date)
- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
 - Date and time
 - Name of individual making entry
 - Names of field team and other persons onsite
 - Description of activity being conducted including station or location (i.e., well, boring, sampling location number) if appropriate
 - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
 - Level of personal protection used
 - Serial numbers of instruments
 - Equipment calibration information
 - Serial/tracking numbers on documentation (e.g., carrier air bills)

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Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Maps, sketches, figures, or data that will not fit on a logbook page should be referenced and attached to the logbook to prevent separation.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.
- Visitors to the site.

5.3 Post-Operation

To guard against loss of data as a result of damage or disappearance of logbooks, completed pages shall be periodically photocopied (weekly, at a minimum) and forwarded to the field or project office. Other field records shall be photocopied and submitted regularly and as promptly as possible to the office. When possible, electronic media such as disks and tapes should be copied and forwarded to the project office.

At the conclusion of each activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed logbook shall be submitted to the records file.

6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and nonsubjective. Field logbooks, and entries within, are not to be used for personal use.

7.0 References

Sandia National Laboratories. 1991. *Procedure for Preparing Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures*, QA-02-03. Albuquerque Environmental Program, Department 3220, Albuquerque, New Mexico.

Sandia National Laboratories. 1992. *Field Operation Procedure for Field Logbook Content and Control*. Environmental Restoration Department, Division 7723, Albuquerque, New Mexico.

TSOP 4-2

PHOTOGRAPHIC DOCUMENTATION OF FIELD ACTIVITIES

Photographic Documentation of Field Activities

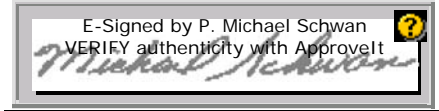
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Date: March 2007

Prepared: David O. Johnson

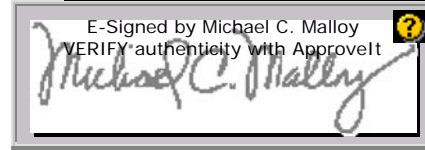
Technical Review: Sharon Budney

QA Review: Jo Nell Mullins

Approved: _____



Issued: _____
Signature/Date



Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include still and digital photography and videotape or DVD recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This document shall provide guidelines designed for use by a professional or amateur photographer. This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

2.0 Background

2.1 Definitions

Photographer - A photographer is the camera operator (professional or amateur) of still photography, including digital photography, or videotape or digital versatile discs (DVD) recording whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Identifier Component - Identifier components are visual components used within a photograph such as visual slates, reference markers, and pointers.

Standard Reference Marker - A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Slates - Slates are blank white index cards or paper used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black indelible marking pens.

Arrows and Pointers - Arrows and pointers are markers/pointers used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds - Contrasting backgrounds are backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Data Recording Camera Back - A data recording camera back is a camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film.

2.2 Associated Procedures

- CDM Federal SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

Photographs and videotape or DVD recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard

reference markers, and pointers. These items shall become an integral part of the “visual media” that, for the purpose of this document, shall encompass still photographs, digital photographs, videotape recordings (or video footage), and recordings on DVDs. The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

3.0 General Responsibilities

Field Team Leader - The field team leader (FTL) is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer - The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP. Responsibilities will be defined in the project sampling plan.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

A general list of equipment that may be used:

- 35mm camera or disposable single use camera (35mm or panoramic use)
- Digital camera
- Extra batteries for 35mm camera
- Video camera and appropriate storage media (e.g., video tapes, DVDs)
- Logbook
- Indelible black or blue ink pen
- Standard reference markers
- Slates
- Arrows or pointers
- Contrasting backgrounds
- Medium speed, or multi purpose fine-grain, color, 35mm negative film or slide film (project dependent)
- Data recording camera back (if available)
- Storage medium for digital camera

5.0 Procedures

5.1 Documentation

A commercially available, bound logbook will be used to log and document photographic activities. Review CDM Federal SOP 4-1, *Field Logbook Content and Control* and prepare all supplies needed for logbook entries.

Note: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log and documentation section.

Field Health and Safety Considerations

There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Federal Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation before commencing field activities. The site health and safety plan must be read before entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., traffic, low overhead hazard, edge of excavation).

5.2 Operation

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from close-up to wide-angle. Many shots will be repetitive in nature or format, especially close-up site feature photographs. Consideration should therefore be given to designing a system or technique that will provide a reliable repetition of performance.
- All still film photographs should be made using a medium speed, or multi purpose fine-grain, color negative film in the 35mm format unless otherwise directed by the FTL.
- It is suggested that Kodak brand "Ektapress Gold Deluxe" film or equivalent be used as the standard film for the still photography requirements of the field activities. This film is stable at room temperature after exposure and will better survive the time lag between exposure and processing. It is suggested that film speed ASA 100 should be used for outdoor photographs in bright sunlight, ASA 200 film should be used in cloudy conditions, and ASA 400 film should be used indoors or for very low-light outdoor photographs.
- No preference of videotape or DVD brand along with digital storage medium is specified and is left to the discretion of the photographer.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. If the ambient lighting conditions are inadequate, the photographer should be prepared to augment the light (perhaps with reflectors or electronic flash) to maintain the desired visual effect.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

5.2.2 General Guidelines for Still Photography

Slate Information

It is recommended that each new roll of film or digital storage medium shall contain on the first usable frame (for film) a slate with consecutively assigned control numbers (a consecutive, unique number that is assigned by the photographer as in sample numbers).

Caption Information

All still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. The caption should contain the following information (digital photographs should have a caption added after the photographs are downloaded):

- | | |
|---|---|
| ■ Film roll control number (if required) and photograph sequence number | ■ Description of activity/item shown (e.g., name of facility/site, specific project name, project number) |
| ■ Date and time | ■ Direction (if applicable) |
| ■ Photographer | |

When directed by the sampling plan, a standard reference marker should be used in all documentary visual media. While the standard reference marker will be predominantly used in close-up feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day to a personal computer; the files should be in either "JPEG" or "TIFF" format. Files should be renamed at the time of download to correspond to the logbook. It is recommended the electronic files be copied to a compact disc for backup.

Close-Up and Feature Photography

When directed by the sampling plan, close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size and contain a slate marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

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Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. When directed by the sampling plan, include a standard reference color strip (color chart such as Munsell Soil Color Chart or that available from Eastman Kodak Co.) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aid to the viewer for formal lithologic observations and interpretations.

Site Photography

Site photography, in general, will consist predominantly of medium- and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the film/tape control number shall be entered in the photographic logbook along with the frame number and all other information pertinent to the scene.

Panoramic

In situations where a wide-angle lens does not provide sufficient subject detail, a single-use disposable panoramic camera is recommended. If this type of camera is not available, a panoramic series of two or three photos would be appropriate. Panoramas can provide greater detail while covering a wide subject, such as an overall shot of a site.

To shoot a panoramic series using a standard 35mm or digital camera, the following procedures are recommended:

- Use a stable surface or tripod to support the camera
- Allow a 20- to 30-percent overlap while maintaining a uniform horizon
- Complete two to three photos per series

5.2.3 General Photographic Documentation Using Video Cameras

As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or "show" videotape or DVD recording. The following guidelines are set for documentary videotape or DVD recordings only and should be implemented at the discretion of the site personnel.

Documentary videotape or DVD recordings of field activities may include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

It is recommended that a standard reference marker and caption/slate be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original video recordings will not be edited. This will maintain the integrity of the information contained on the videotape or DVD. If editing is desired, a working copy of the original video recording can be made.

A label should be placed on the videotape or DVD with the appropriate identifying information (project name, project number, date, location, etc.).

5.2.4 Photographic Documentation

Photographic activities must be documented in a photographic logbook or in a section of the field logbook. The photographer will be responsible for making proper entries.

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In addition to following the technical standards for logbook entry as referenced in CDM Federal SOP 4-1, the following information should be maintained in the appropriate logbook:

- Photographer name.
- If required, an entry shall be made for each new roll/tape/DVD control number assigned.
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used).
- Date and time (military time).
- Location.
- A description of the activity/item photographed.
- If needed, a description of the general setup, including approximate distance between the camera and the subject, may be recorded in the logbook.
- Record as much other information as possible to assist in the identification of the photographic document.

5.3 Post Operation

All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer shall also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape or DVD to the project management representative to be placed in the project files.

5.3.1 Documentation

At the end of each day's photographic session, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in CDM Federal SOP 4-1.

5.3.2 Archive Procedures

- Photographs and the associated set of uncut negatives, digital media, and original unedited documentary video recordings will be submitted to the project files and handled according to contract records requirements. The project manager will ensure their proper distribution.
- Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines for the field amateur or professional photographer to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The photographer is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the project manager or FTL.

Note: Some sites do not permit photographic documentation. Check with the site contact for any restrictions.

7.0 References

U. S. Army Corps of Engineers. 2001. *Requirements for the Preparation of Sampling and Analysis Plans*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. 1992. National Enforcement Investigations Center. *Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p. 85. Revised March.

_____. Region IV. 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. Athens, Georgia. November.

TSOP 4-3
WELL DEVELOPMENT AND PURGING

Well Development and Purging

SOP 4-3
Revision: 5
Date: March 2007

Prepared: Del R. Baird

Technical Review: John Hofer

QA Review: Jo Nell Mullins

Approved: 

Issued: 
Signature/Date

Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to define the procedural requirements for well development and purging.

2.0 Background

Monitoring wells are developed to repair damage to the formation caused by drilling activities and to settle and remove fines from the filter pack. Wells shall not be developed for at least 24 to 48 hours after completion when a cement bentonite grout is used to seal the annular space; however, wells may be developed before grouting if conditions warrant. Wells are purged immediately before groundwater sampling to remove stagnant water and to sample representative groundwater conditions. Wells shall be sampled within 3 hours of purging (optimum) to 24 hours after purging (maximum, for low recharge conditions).

2.1 Associated Procedures

- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that development and purging are carried out in accordance with this procedure.

Field Team Leader - The field team leader is responsible for complying with this procedure.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Pump, pump tubing, or bailer and rope or wire line
- Power source (e.g., generator), if required
- Electronic water-level meter
- Temperature, conductivity, pH, and turbidity meters
- Personal protective equipment as specified in the site-specific health and safety plan
- Decontamination supplies, as required, according to CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*
- Disposal drums, if required
- Photoionization detector (PID) or equivalent as specified in site-specific health and safety plan

5.0 Procedures

5.1 Well Development

The following steps must be followed when developing wells:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.
4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
5. Determine the depth to static water level and depth to bottom of the well.
6. Prepare the necessary equipment for developing the well. There are a number of techniques that can be used to develop a well. Some of the more common methods are bailing, overpumping, backwashing, mechanical surging, surge and pump, wire brush, swabbing, and high-velocity jetting. All of these procedures are acceptable; however, final approval of the development method rests with the appropriateness of a specific method to the site and the client.
7. For screened intervals longer than 10 feet (3 meters [m]), develop the well in 2- or 3-foot (0.75- or 1-m) intervals from bottom to top. This will ensure proper packing of the filter pack.
8. Continue well development until produced water is clear and free of suspended solids, as determined by a turbidity meter or when pH, conductivity, and temperature have stabilized. Record pertinent data in the field logbook and on appropriate well development forms. Remove the pump assembly or bailers from the well, decontaminate (if required), and clean up the area. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

5.2 Volumetric Method of Well Purging

The following steps shall be followed when purging a well by the volumetric method:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.
4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
5. Determine the depth to static water level and depth to bottom of well casing according to CDM Federal SOP 1-6, *Water Level Measurement*. Calculate the volume of water within the well bore using the following formula (or equivalent):

$$7.4805 \left[\frac{D^2 \pi}{(4)} \right] dH = \text{volume (in gallons)}$$

where

D = casing diameter in feet. (**Note:** This equation is used for grouted wells with short screens. For wells with long screens and/or ungrouted wells, the D = borehole diameter in feet).

dH = the distance from well bottom to static water level in feet.

$\pi = 3.1416$.

Note: Record all data and calculations in the field logbook.

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6. Prepare the pump and tubing, or bailer, and lower it into the casing.
7. Remove the number of well volumes specified in the site-specific plans. Generally, three to five well volumes will be required. Conductivity, pH, temperature, and turbidity shall be measured and recorded. Purging shall continue until the field parameters have stabilized. Groundwater quality parameters are considered stable when three consecutive readings are within ± 0.1 for pH, ± 3 percent for conductivity, ± 10 mv for redox potential (ORP), and ± 10 percent for turbidity if greater than 10 NTU, in accordance with site-specific plans. Efforts shall be made to get turbidity below 10 NTU, especially if groundwater samples are to be collected for metals or PCB analyses.
8. In low recharge aquifers, the following steps shall be followed: (1) If the initial water level is less than 10 feet above the top of the screen, then purge to dryness and allow sufficient recharge to collect samples. (2) If initial water level in the well is more than 10 feet above the top of the screen, then care shall be taken to prevent the dewatering of the screened interval. (3) Continue purging until the water level is between 1 and 5 feet above the top of the screen. (4) Allow well to recharge then continue purging until at least 1 full initial well volume has been purged. (5) Record pertinent data in the field logbook.
9. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with volatiles organic compounds (VOCs). After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.
10. After sampling activities have been completed, remove the pump assembly or bailer from the well, decontaminate it (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plan.

5.3 Indicator Parameter Method of Well Purging

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
3. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.
4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
5. Determine the depth to static water level and depth to bottom. Set up surface probe(s), (e.g., pH, conductivity) at the discharge orifice or dedicated probe port of the pump assembly or within the flow-through chamber. Allow probe(s) to equilibrate according to manufacturer's specifications. Record the equilibrated readings in the field logbook.
6. Assemble the pump and tubing, or bailer, and lower into the casing.
7. Begin pumping or bailing the well. Record indicator parameter readings for every 5 minutes or purge volume, whichever is quicker. Maintain a record of the approximate volumes of water produced. Care shall be taken to minimize drawdown (0 to 0.2 feet).
8. Continue pumping or bailing until indicator parameter readings remain stable within ± 0.1 for pH, ± 3 percent for conductivity, ± 10 mv for redox potential (ORP), and ± 10 percent for turbidity if greater than 10 NTU for three consecutive recording intervals and a minimum of 1 well volume is removed, or in accordance with site-specific plans. Purging shall continue until the discharge stream is clear or turbidity becomes asymptotic-low or meets project requirements.

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9. For a low recharge aquifer, follow the guidelines of Section 5.2, Paragraph 7.
10. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with VOCs. After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.
11. Remove the pump assembly or bailer from the well, decontaminate (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

6.0 Restrictions/Limitations

Where flammable, free, or emulsified product is expected, or known to exist on or in groundwater, use intrinsically safe electrical devices only and place portable power sources (e.g., generators) 50 feet (15 m) or further from the wellhead and disposal drums.

7.0 References

American Society for Testing and Materials. 2005. Designation: D 5521, *Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers*, Rev. 5, November.

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TSOP 4-4

DESIGN AND INSTALLATION OF MONITORING WELLS IN AQUIFERS

Design and Installation of Monitoring Wells in Aquifers

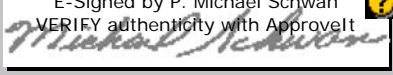
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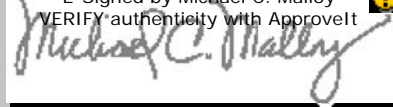
Prepared: Del Baird

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QA Review: Jo Nell Mullins

Approved:

E-Signed by P. Michael Schwan
VERIFY authenticity with ApproveIt


E-Signed by Michael C. Malloy
VERIFY authenticity with ApproveIt


Signature/Date

Issued:

Signature/Date

1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide guidelines for the installation of groundwater monitoring wells. These guidelines will help to produce consistency of approach in the design and installation of monitoring wells. Individual installations will probably vary in some respects since they may encounter differing hydrogeologic conditions.

2.0 Background

2.1 Definitions

Monitoring Well Installation - The act of installing well casing, screen, filter pack, bentonite seal, grout, and other specified materials in a borehole to construct a complete monitoring well.

2.2 Associated Procedures

- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-2, *Photographic Documentation of Field Activities*
- CDM Federal SOP 4-3, *Well Development and Purging*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

This SOP is intended to cover the installation of monitoring wells for use in conducting a variety of environmental investigations. It is intended to be a general guideline listing the types of materials and methods to be considered when a well is installed. Materials are not specified in detail since it is likely there will be wide variability required to meet the needs of individual site conditions or specific clients. Ideally, the well shall not alter the medium that is being sampled.

3.0 General Responsibilities

Site Manager - Translates client's requirements into technical direction of project. Sets technical criteria, reviews and approves technical progress, and ensures that all participating personnel have proper training. **Note:** Other titles such as project manager may be used.

Field Team Leader (FTL) - Supervises field operations. Ensures that all necessary equipment including safety equipment is available and functioning properly before project operations begin. Ensures that all necessary personnel are mobilized on time. Maintains daily log of activities each work day.

Field Geologist - Collects and maintains data and completes Monitoring Well Construction Forms. Coordinates and consults with site manager on decisions relative to unexpected encounters during well installation and deviation from this SOP. Directs overall activities of drill and support subcontractors.

Drilling Subcontractor - Provides necessary personnel, equipment, and services to meet terms of the contract.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment and Materials

4.1 Required Equipment

- Field logbook
- Monitoring Well Construction Forms
- Measuring tape

4.2 Required Construction Materials

General - The materials that are used in the construction of a monitoring well and that come in contact with the groundwater shall not measurably alter the chemical quality of a groundwater sample. The well casing and well screen shall be steam cleaned (if appropriate for the selected material) before well installation or certified clean from the manufacturer and delivered to the site in protective wrapping. Samples of the cleaning water, drilling fluids, filter pack, annular seal, and mixed grout shall be retained to be analyzed if groundwater contamination as the result of well installation is suspected. These samples will serve as quality control checks until the completion of at least one round of groundwater quality sampling and analysis.

Water - Water, which may be used in the well completion process, shall be obtained from a source that does not contain constituents that could compromise the integrity of the well installation. A certificate of analysis shall be provided with the water, or a sample of the water shall be analyzed and documented as contaminant-free.

Surface (Isolation) Casing - Surface, or isolation, casing may be required to isolate an upper aquifer while drilling and installing deep wells. The isolation casing usually consists of black steel or polyvinyl chloride (PVC). Surface casings shall be large enough to allow a minimum annular space of 2 inches between it and the well casing. Segments of black steel casings are typically welded together as the casing is lowered down the borehole. PVC isolation casings are either flush-threaded or have a bell shape at one end so that sections slip together and are held with small stainless steel screws. Casings shall be grouted in place and allowed to set for 12 to 24 hours before advancing the borehole below the casing.

Well Screen - The well screen shall be new and composed of materials most suited for the environment being monitored. The screened interval shall be plugged at the bottom. The plug shall be of the same material as the bottom section of screen and shall be securely attached, making a positive seal. This assembly must have the capability to withstand well installation and development stresses without becoming dislodged or damaged. The length of the well screen slotted area shall be appropriate for the interval to be monitored including some allowance for changes in elevation of the water table. Before installation, the casing string and associated equipment shall be cleaned with steam or high-pressure water, if not certified cleaned. Well screens shall be stainless steel or PVC, as appropriate. Fluoropolymer materials may be substituted if necessary because of the potential for incompatible chemical reactions between contaminants and the stainless steel screen, or if stainless steel constituents are possible site contaminants. The minimum inside diameter of the well screen shall be chosen based on the particular application. Well screens shall be flush threaded per American Society for Testing and Materials (ASTM) standards. Glued or solvent-welded joints may not be used since glues and solvents may alter the chemistry of the water samples.

The slot size of the well screen shall be determined relative to the grain-size analysis of the stratum to be monitored and the gradation of the filter pack material. In granular, noncohesive, strata that falls in easily around the screen, filter packs may not be necessary. In these cases of natural development, the slot size of the well screen is to be determined using the grain size of the surrounding strata. The slot size and arrangement shall retain at least 90 percent of the filter pack.

Casing - The well casing will be PVC, stainless steel, or some other appropriate material and will extend from the screen to the surface. The type of casing and wall thickness shall be adequate to withstand the forces of installation. Several different casing sizes may be required depending on the subsurface geologic conditions. The diameter of the casing for filter packed wells shall be selected so that a minimum annular space of 2 inches is maintained between the casing and the borehole wall. The diameter of the casings in multi-cased wells shall be selected so that a minimum annular space of 2 inches is maintained between casing strings and between the outer casing and the borehole (e.g., a 2-inch-diameter well screen will require first setting a 6-inch-diameter casing in a 10-inch-diameter boring). Under difficult drilling conditions (collapsing soils, rock, or cobbles), it may be necessary to advance temporary casing. Under these conditions, a smaller space may be maintained. The ends of each casing section shall be flush-threaded.

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Primary Filter Pack - The primary filter pack (sand or gravel pack) consists of a clean, well-sorted, rounded granular material of selected grain size and gradation that is installed in the annulus between the screened interval and the borehole wall. The filter pack may be installed along the screened interval using a tremie pipe from the total depth of the well to the designated distance above the top of the screened interval. A filter pack material mostly consisting of siliceous, rather than calcareous, particles is preferred. Select the grading of the filter pack on the basis of the layer of finest material to be screened. A minimum filter pack thickness shall be between 2 to 3 inches and generally shall never be greater than 8 inches. The filter pack shall extend at least 2 to 3 feet above the screened interval or more depending on the screen length to provide for filter pack settlement.

Transition Sand - A layer of fine to very fine sand may be placed on top of the primary filter pack before emplacement of the bentonite seal. The sand shall be of sufficient thickness to prevent bentonite from penetrating to the vicinity of the well screen during placement of the bentonite seal.

Annular Sealants - The materials used to seal the annulus may be prepared as a slurry or used unmixed in a dry pellet form. Sealants shall be selected for compatibility with local geologic, hydrogeologic, climatic, and human-induced conditions anticipated to occur during the life of the well.

Grout - The grout backfill that is placed above the bentonite annular seal shall be a liquid slurry consisting of water, bentonite grout of Volclay or equivalent quality, and portland cement. Bentonite-based grouts are typically used when a more flexible grout is desired (i.e., freeze-thaw). Cement-based grout provides a more rigid installation. A typical bentonite grout mixture is 1 to 1.25 pounds bentonite to 2 pounds of Type I portland cement per gallon of water. Cement-based grout is typically 6 to 7 gallons of water per 94 pound bag of Type I portland cement and 2.7 percent bentonite powder.

Bentonite - Bentonite shall be powdered or pelletized sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities that adversely impact water quality in the well. The diameter of pellets selected for monitoring well construction shall be less than one-fifth the width of the annular space into which they are placed to reduce the potential for bridging. Pellets are typically used for placing annular seals, and powdered bentonite is used for mixing in grout slurry.

Cement - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement shall generally be portland Type I, Type II, or Type I/II as specified in ASTM C 150. Quick-setting cements containing additives are not allowable for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of the groundwater.

Annular Seal Equipment (Tremie Pipe) - A tremie pipe is used to inject the annular seals and filter pack. Tremie pipes are typically constructed of PVC or galvanized steel. Associated equipment may include a trough or mixing box and "mud pump" to place the material.

Protective Casing - Protective casings are installed on wells placed in overgrown or nontraffic areas. The casings may be made of galvanized steel (or rarely stainless steel and shall have a lid capable of being secured by a locking device. The inside dimensions of the protective casing shall be at a minimum 4 inches larger than the diameter of the casing to facilitate the installation and operation of sampling equipment. Protective casing shall extend approximately 2 to 3 feet into the ground to anchor it securely. Protective casings are typically set in concrete pads measuring 2 feet x 2 feet to 4 feet x 4 feet and 4 to 6 inches thick depending on client requirements.

Flush-Mount Protective Covers - Flush-mount covers (Christy boxes) are installed over wells place in paved or manicured areas. The covers are typically 8 inches in diameter with a 1-foot galvanized steel skirt and cast iron bolt-down ring and lid. The covers are installed in concrete pads measuring 2 to 3 feet square that are constructed so as to not impede vehicle traffic and sloped from the center toward the edges to prevent infiltration of run-off water.

5.0 Procedures

5.1 Drilling Methods

The actual methods of drilling at a site will vary depending on site conditions. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL or

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designee. Typical drilling methods include air rotary or hammer, mud/fluid rotary, roto-sonic, and hollow-stem auger. Drilling with mud or water is least desirable, but the driller shall have the capability to use this method if borehole conditions warrant it. Installation of isolation casing, if required, shall be done by either penetrating the outer casing into the ground by hammer blows or by drilling a borehole. The outer casing shall be set and secured by grouting or other means specified in the site-specific plans. The inner well borehole can then be drilled through the center of the outside casing. The monitoring wells shall be drilled vertical or at an angle if specified in the site-specific plans. The wells shall be drilled to a depth specified in the site-specific plans and may vary based on actual lithologic conditions. The depth to completion shall be approved by the FTL or designee before monitoring well construction. Drillers must prevent grease, oil, and other fluids from the drill rig from coming in contact with the ground around the area of well installation.

Collection of continuous core may be required during borehole drilling. Samples may be collected by several methods depending on project needs and the material being sampled including split-spoon sampler, direct-push, or sonic coring (unconsolidated material), or wire-line coring (bedrock). A description of soil/lithologic materials and drilling observations needs to be recorded on a boring log or in a logbook (CDM Federal SOP 3-5).

5.2 Monitoring Well Installation

5.2.1 Stable Borehole

A stable borehole must be constructed before attempting to install the monitoring well. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow-in, or both. Boreholes that are not straight or are partially obstructed shall be corrected before attempting the installations described herein.

Although all monitoring wells will not be completed exactly alike, there are common elements among them. The Monitoring Well Construction Form(s) (Figures 1, 2, 3, and 4 or equivalent) must be completed by the end of the activity with data obtained through the installation process. Modification of the construction and dimensions on this diagram may be needed depending on site-specific conditions. The well construction field form shall be reviewed before initiation of drilling activities to ensure that the required data are collected at appropriate times during drilling and installation.

5.2.2 Well Casing Assembly

The well screen, casing, and bottom plug shall be either certified clean from the manufacturer or decontaminated according to CDM Federal SOP 4-5.

The casing shall be flush-threaded, using Schedule 40 PVC or other suitable monitoring well casing. No adhesives, cements, or lubricants shall be used during casing make-up or during other drilling and well completion operations. Personnel shall take precautions to ensure that grease, oil, or other contaminants that may alter water samples do not contact any portion of the well casing assembly. As a precaution, personnel shall wear a pair of clean gloves while handling the assembly.

Normally, couplings are tightened by hand; however, steam- or high-pressure-cleaned strap wrenches may also be used. Use pipe wrenches with care as they may scar and weaken the pipe. Precautions shall be taken to prevent damage to the threaded joints during installation.

5.2.3 Setting the Well Screen and Casing Assembly in Fluid Filled Holes

When the well screen and casing assembly is lowered to the predetermined level and held in position, the assembly may require a ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by continuously filling the casing assembly with contaminant-free water. If fluid ballasts are used, the quantity introduced must be recorded in the field logbook. Alternatively, the casing assembly may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of casing are added to the column. Care must be taken to secure the casing assembly so that personnel safety is ensured during the installation. For wells greater than 100 feet, the assembly shall be installed straight using centralizers at selected intervals.

The casing shall extend to grade or approximately 2 feet above grade, depending on the intended surface completion, and be capped or covered temporarily to deter entrance of foreign materials during completion operations.

5.2.4 Installation of the Primary Filter Pack

Placement of the casing assembly is followed by placing the primary filter pack (consisting of silica sand sized according to the average grain size of the screened formation) into the bottom of the borehole by using a tremie pipe. The primary filter pack is placed in increments as the tremie is gradually raised. The sand pack will be emplaced by the "washdown" gravity method and the depth to the top of the sand pack shall be determined and recorded frequently during the operation to ensure proper placement. The tremie pipe or a weighted line inserted through the tremie pipe can be used to measure the top of the primary filter pack as work progresses. As primary filter pack material is poured into the tremie pipe, potable water is used to help move the sand through the tremie pipe. The quantity of water introduced shall be recorded in a field logbook. If bridging of the primary filter pack occurs, the bridged material shall be broken mechanically before proceeding with the addition of more filter pack material. The depth, volume, and gradation of the primary filter pack will be recorded on the well construction diagram.

If used, temporary casing or auger sections will be withdrawn in increments as the sand pack is emplaced. Care shall be taken to minimize lifting the casing with the withdrawal of the temporary casing/augers. To limit borehole collapse, the temporary casing or hollow-stem auger is usually withdrawn until the lowermost point on the temporary casing or hollow-stem auger is at least 2 feet, but no more than 5 feet, above the filter pack for unconsolidated materials; or at least 5 feet, but no more than 10 feet, for consolidated materials. Ascertain the depth of the sand with an acceptable measuring device or with tremie pipe and verify the thickness of the sand pack. The primary filter pack is typically placed a minimum of 2 feet above the top of the well screen to account for settlement of the filter pack.

5.2.5 Installation of the Bentonite Seal

A minimum 2-foot-thick bentonite seal shall be emplaced on top of the filter pack or transition sand (if used) and is generally emplaced by gravity feed. The bentonite shall be slowly fed into the annulus and carefully monitored to ensure that bridging is not taking place. Time-release pellets coated with a food-grade coating must be used in deep well applications to prevent premature expansion of the bentonite.

Some clients may require installing the bentonite seal by using a tremie pipe. This type of installation shall be accomplished by washing the bentonite pellets through the tremie pipe with potable water. If the tremie pipe becomes plugged, requiring an increase in pressure to clear it, not less than 20 feet of tremie pipe shall be pulled up to avoid jetting into the sand pack. If the seal is installed above the water level, water shall be added to allow proper hydration of the annular seal (approximately 1 gallon for each linear foot of annular seal). The volume and depth of the bentonite seal material shall be measured and recorded on the well construction diagram.

5.2.6 Grouting the Annular Space

The following procedures apply to both single- and multi-cased monitoring wells. However, it shall be noted that grouting procedures will vary with the type of well design.

A sufficient volume of grout shall be premixed onsite, according to procedure stipulated by the manufacturer, to compensate for unexpected losses and checked against the known volume of annular space to ensure that bridging does not occur during emplacement. The use of alternate grout materials, including grout containing portland cement, may be necessary to control zones of high grout loss. The mixing (and placing) of grout shall be performed with recorded weights and volumes of materials, according to procedures stipulated by the manufacturer. Lumpy grout shall not be used in an effort to prevent bridging within the tremie and the well. Bentonite-based grout of Volclay or equivalent type shall be mixed to the manufacturer's specifications then pumped into place using minimum pump pressure. All additives to grouts shall be evaluated for their effects on subsequent water samples.

Depending upon the well design, grouting may be accomplished using a pressure grouting technique or by gravity feed through a tremie pipe. With either method, grout is introduced in one continuous operation until grout flows out at the ground surface without evidence of drill cuttings or fluid. The grout backfill shall be injected under pressure using a tremie pipe to reduce the possibility of leaving voids in the annular seal and to displace any liquids and drill cuttings that may remain in the annulus.

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Grouting shall begin directly above the bentonite seal, after the bentonite has been adequately hydrated. Grout shall be injected using a tremie pipe. The tremie pipe shall be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Pump pressure shall be kept to a minimum. Approximately 5 to 10 feet of tremie pipe shall remain submerged during group emplacement. If possible, steel tape soundings shall be made to ensure the level of the tremie material is in agreement with the calculated volume and that the desired placement of annular materials is achieved. A staged grouting procedure may be considered if the couplings of the selected casing cannot withstand the shear or if there is collapse stress exerted by the full column of grout as it sets. If used, the temporary casing or hollow-stem auger shall be removed in increments (immediately following each lift of grout installation) well in advance of the time when the grout begins to set. The initial grout mixture must be allowed to cure for approximately 12 hours, then refilled to the surface.

The well casing shall not be developed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and casing. The amount of time required (generally 24 to 48 hours) will vary with grout content and climate conditions and shall be documented on the well completion diagram along with the volume and depth of grout used to backfill the annular space.

5.3 Well Protection

Well protection refers specifically to installations made at or above the ground surface to deter unauthorized entry to the monitoring well, prevent damage, and to prevent surface water from entering the annulus.

The protective casing shall extend from below the frost line (at least 2 feet below grade) to slightly above the well casing top. The protective casing shall be sealed and immobilized in concrete that has been placed around the outside of the protective casing above the set grout backfill. The casing shall be positioned and stabilized in a position concentric with the casing. Clearance (usually 6 inches) shall be maintained between the lid of the protective casing and the top of the casing to accommodate sampling equipment. A ¼-inch-diameter weep hole shall be drilled in the protective casing at the ground surface to permit water to drain out of the annular space. This hole will also prevent water freezing between the well protector and the well casing.

All materials used shall be documented on the well construction diagram. The monitoring well identification number shall be clearly visible on the inside and outside of the lid of the protective casing and the outside of the protective casing.

A 3-foot x 3-foot x 6-inch-thick concrete pad, sloped to provide water drainage away from the well, may be placed around the installation. Pad size may vary according to site conditions or client specifications. Three to four 2½-inch-diameter concrete-filled steel posts set at least 24 inches below the surface in concrete shall be equally spaced around the well to protect against damage by vehicular traffic for aboveground well completions. The protective casing and steel posts may be primed and painted with rust-resistant yellow paint. The annulus between the well casing and the protective casing may be filled with sand to approximately 1 foot below the top of the well casing to help stabilize the well casing and prevent the loss of tools or equipment in the annular space.

A flush-mounted, traffic-rated casing or vault is typically used for the surface completion of monitoring wells installed in high-use paved or maintained grass (landscaped) areas. The well box cover shall be finished slightly above pavement or ground surface to prevent water entry. A layer of sand or gravel material shall be placed under the casing/vault to allow infiltrating surface water to drain out.

5.4 Post Operation

5.4.1 Field

At the conclusion of the monitoring well installation activities, all equipment must be decontaminated (according to CDM Federal SOP 4-5) before moving the equipment to a different work location. All water used in the decontamination of drilling equipment will be contained in an appropriate container, if required in the site-specific plans.

5.4.2 Documentation

The Groundwater Monitoring Well Construction Form (Figures 1, 2, 3, and 4 or equivalent) shall be completed by the CDM FTL or designee at the conclusion of the field activity.

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Copies of all field notes, the daily logs, and any completed Groundwater Monitoring Well Construction Forms shall be given to the site manager. These records shall be maintained in the project and document control files. At a minimum, all materials used for construction shall be documented by entering identifying numbers (lot numbers, manufacturer's identification, etc.) in the field logbook. Samples of well materials (including grout, sand, etc.) may be archived if specified in the project plans.

6.0 Restrictions and Limitations

None.

7.0 References

American Society for Testing and Materials. 2001. Designation: D 6725, *Standard Practice for Direct-Push Installation of PrePacked Screen Monitoring Wells in Unconsolidated Aquifers*, Rev. 1. November.

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Driscoll, F. G. 1986. *Groundwater and Wells*, 2nd Ed. Johnson Division. St. Paul, Minnesota.

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Figure 1

Typical Construction Detail of Above-Grade Single-Cased Monitor Well
(Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA

TOTAL DEPTH OF BOREHOLE _____

HOLE DIAMETER _____

DRILLING METHOD _____

CONSTRUCTION DATA

CASING LENGTH _____

CASING DIAMETER _____

CASING MATERIAL _____

JOINT DESIGN _____

SEAL _____

FILTER PACK _____

SCREEN SIZE _____

SCREEN MATERIAL _____

A. CASING ELEVATION ABOVE GROUND _____

B. DEPTH TO TOP OF CASING _____

C. DEPTH OF TOP OF GROUT _____

D. DEPTH TO TOP OF BENTONITE _____

E. DEPTH TO TOP OF SAND _____

F. DEPTH TO TOP OF SCREEN _____

G. TOTAL WELL DEPTH _____

H. WATER FIRST NOTICED _____

I. DEPTH TO WATER AT COMPLETION _____

CLIENT _____

DRILLING CONTRACTOR _____

DRILL RIG _____

DRILLERS _____

INSTALLATION DATE _____

LOGGED BY _____

NOT TO SCALE

CDM

Details of Monitoring Well _____
Project _____
Project Location _____

Figure 2

Typical Construction Detail of Flush-Mount Single-Cased Monitor Well
(Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA

TOTAL DEPTH OF BOREHOLE _____

HOLE DIAMETER _____

DRILLING METHOD _____

CONSTRUCTION DATA

CASING LENGTH _____

CASING DIAMETER _____

CASING MATERIAL _____

JOINT DESIGN _____

SEAL _____

FILTER PACK _____

SCREEN SIZE _____

SCREEN MATERIAL _____

A. CASING ELEVATION ABOVE GROUND _____

B. DEPTH TO TOP OF CASING _____

C. DEPTH OF TOP OF GROUT _____

D. DEPTH TO TOP OF FINE SAND _____

E. DEPTH TO TOP OF SAND _____

F. DEPTH TO TOP OF SCREEN _____

G. TOTAL WELL DEPTH _____

H. WATER FIRST NOTICED _____

I. DEPTH TO WATER AT COMPLETION _____

CLIENT _____

DRILLING CONTRACTOR _____

DRILL RIG _____

DRILLERS _____

INSTALLATION DATE _____

LOGGED BY _____

NOT TO SCALE

CDM

Details of Monitoring Well _____
Project _____
Project Location _____

Figure 3

**Typical Construction Detail of Above-Grade Double-Cased Monitor Well
(Not to Scale - Shown as an Example Only)**

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA

TOTAL DEPTH OF BOREHOLE _____

HOLE DIAMETERS _____

DRILLING METHOD(S) _____

SURFACE CASING

DEPTH TO BEDROCK _____

TOTAL DEPTH OF CASING _____

CASING DIAMETER _____

CASING MATERIAL _____

CONSTRUCTION DATA

CASING LENGTH _____

CASING DIAMETER _____

CASING MATERIAL _____

JOINT DESIGN _____

SEAL _____

FILTER PACK _____

SCREEN SIZE _____

SCREEN MATERIAL _____

A. CASING ELEVATION ABOVE GROUND _____

B. DEPTH TO TOP OF CASING _____

C. DEPTH OF TOP OF GROUT _____

D. DEPTH TO TOP OF BENTONITE _____

E. DEPTH TO TOP OF SAND _____

F. DEPTH TO TOP OF SCREEN _____

G. TOTAL WELL DEPTH _____

H. WATER FIRST NOTICED _____

I. DEPTH TO WATER AT COMPLETION _____

CLIENT _____

DRILLING CONTRACTOR _____

DRILL RIG _____

DRILLERS _____

INSTALLATION DATE _____

LOGGED BY _____

NOT TO SCALE

Details of Monitoring Well _____
Project _____
Project Location _____

CDM

Figure 4

Typical Construction Detail of Flush-Mount Double-Cased Monitor Well
(Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA

TOTAL DEPTH OF BOREHOLE _____

HOLE DIAMETERS _____

DRILLING METHOD(S) _____

SURFACE CASING

DEPTH TO BEDROCK _____

TOTAL DEPTH OF CASING _____

CASING DIAMETER _____

CASING MATERIAL _____

CONSTRUCTION DATA

CASING LENGTH _____

CASING DIAMETER _____

CASING MATERIAL _____

JOINT DESIGN _____

SEAL _____

FILTER PACK _____

SCREEN SIZE _____

SCREEN MATERIAL _____

A. CASING ELEVATION ABOVE GROUND _____

B. DEPTH TO TOP OF CASING _____

C. DEPTH OF TOP OF GROUT _____

D. DEPTH TO TOP OF BENTONITE _____

E. DEPTH TO TOP OF SAND _____

F. DEPTH TO TOP OF SCREEN _____

G. TOTAL WELL DEPTH _____

H. WATER FIRST NOTICED _____

I. DEPTH TO WATER AT COMPLETION _____

CLIENT _____

DRILLING CONTRACTOR _____

DRILL RIG _____

DRILLERS _____

INSTALLATION DATE _____

LOGGED BY _____

NOT TO SCALE

CDM

Details of Monitoring Well _____
Project _____
Project Location _____

TSOP 4-5

FIELD EQUIPMENT DECONTAMINATION AT NONRADIOACTIVE SITES

Field Equipment Decontamination at Nonradioactive Sites

SOP 4-5
Revision: 7
Date: March 2007

Prepared: Steven Fundingsland

Technical Review: Mike Higman

QA Review: Jo Nell Mullins

Approved: 

Issued: 

Signature/Date

Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to describe the general procedures required for decontamination of field equipment at nonradioactive sites. This SOP serves as a general guide and is applicable at most sites; however, it shall be noted that site-specific conditions (i.e., type of contamination, type of media sampled), the governing agency (e.g., EPA, DOE, USACE), and site-specific work plans, sampling and analysis plans and/or quality assurance (QA) project plans may require modifications to the decontamination procedures provided in this SOP. Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants offsite.

2.0 Background

2.1 Definitions

Acid Rinse - A solution of 10 percent nitric or hydrochloric acid made from reagent grade acid and analyte-free water.

Analyte-Free Water - Tap water that has been treated so that the water contains no detectable heavy metals or other inorganic compounds. Analyte-free water shall be stored only in clean glass, stainless steel, or plastic containers that can be closed when not in use.

Clean - Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross Contamination - The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or noncontaminated samples or areas.

Decontamination - The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

Material Safety Data Sheets (MSDS) - These documents discuss the proper storage and physical and toxicological characteristics of a particular substance used during decontamination. These documents, generally included in site health and safety plans, shall be kept on site at all times during field operations.

Organic-Free/Analyte-Free Water - Tap water that has been treated so that the water meets the analyte-free water criteria and contains no detectable organic compounds. Organic-free/analyte-free water shall be stored only in clean glass, Teflon™, or stainless steel containers that can be closed when not in use.

Potable Water - Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used.

Sampling Equipment - Equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and spatulas or bowls used to homogenize samples.

Soap - Low-sudsing, nonphosphate detergent such as Liquinox™.

Solvent Rinse - Pesticide grade, or better, isopropanol, acetone, or methanol.

2.2 Associated Procedures

- CDM Federal SOP 1-1 - *Surface Water Sampling*
- CDM Federal SOP 1-3 - *Surface Soil Sampling*
- CDM Federal SOP 1-4 - *Subsurface Soil Sampling*
- CDM Federal SOP 1-5 - *Groundwater Sampling Using Bailers*
- CDM Federal SOP 1-7 - *Wipe Sampling*
- CDM Federal SOP 1-9 - *Tap Water Sampling*
- CDM Federal SOP 1-11 - *Sediment/Sludge Sampling*
- CDM Federal SOP 2-2 - *Guide to Handling Investigation-Derived Waste*
- CDM Federal SOP 3-1 - *Geoprobe® Sampling*

3.0 Responsibilities

The project manager or designee, generally the field team leader (FTL), ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this SOP and site-specific work plans. The FTL may also be required to collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QA plan.

4.0 Required Equipment

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Soap
- Nalgene or Teflon sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water*
- Analyte-free water
- Organic-free/analyte-free water
- Gloves, safety glasses, and other protective clothing as specified in the site-specific health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source (e.g., 10 percent and/or 1 percent nitric acid [HNO_3], acetone, methanol, isopropanol, hexane)
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums or tanks for temporary storage of decontamination water (as required)
- Pallets for drums or tanks holding decontamination water (as required)

* Potable water may be required to be tested for contaminants before use. Check field plan for requirements.

5.0 Procedures

All reusable equipment (nondedicated) used to collect, handle, or measure samples shall be decontaminated before coming into contact with any sampled media or personnel using the equipment. Decontamination of equipment shall occur either at a central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally located decontamination station shall include an appropriately sized bermed and lined area on which equipment decontamination shall occur and shall be equipped with a collection system and storage vessels. In certain circumstances, berming is not required when small quantities of water are being generated and for some short duration field activities (i.e., pre-remedial sampling). Equipment shall be transported to and from the decontamination station in a manner to prevent cross contamination of equipment and/or area. Precautions taken may include enclosing augers in plastic wrap while being transported on a flatbed truck.

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The decontamination area shall be constructed so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) or within the berms of the decontamination area that then drains into a collection system. Water from the collection system shall be transferred into 55-gallon drums or portable tanks for temporary storage. Typically, decontamination water shall be staged until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined (SOP 2-2, *Guide to Handling Investigation-Derived Waste*). The exact procedure for decontamination waste disposal shall be discussed in the work plan. Also, solvent and acid rinse fluids may need to be segregated from other investigation-derived wastes.

All items that shall come into contact with potentially contaminated media shall be decontaminated before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, they shall be covered either with clean plastic or aluminum foil depending on the size of the item. All decontamination procedures for the equipment being used are as follows:

General Guidelines

- Potable, analyte-free, and organic-free/analyte-free water shall be free of all contaminants of concern. Following the field QA sampling procedure described in the work plan, analytical data from the water source may be required.
- Sampling equipment that has come into contact with oil and grease shall be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or client requirements regarding solvent use shall be stated in the work plan.
- All solvents and acids shall be pesticide grade or better and traceable to a source. The corresponding lot numbers shall be recorded in the appropriate logbook.

Note: Solvents and acids are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents shall never be used in a closed building. See the site-specific health and safety plan and/or the chemical's MSDS for specific information regarding the safe use of the chemical.

- Decontaminated equipment shall be allowed to air dry before being used.
- Documentation of all cleaning and field QA sampling shall be recorded in the appropriate logbook.
- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the site-specific health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment includes drilling rigs, well development rigs, and backhoes. Follow these steps when decontaminating this equipment:

- Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads shall be upwind of the area under investigation.
- With the rig in place, spray areas (rear of rig or backhoe) exposed to contaminated media using a hot water high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.
- Use brushes, soap, and potable water to remove dirt whenever necessary.
- Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.
- Record the equipment type, date, time, and method of decontamination in the appropriate logbook.

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- After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the field plan. Liquids and solids must be drummed separately.

5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, stems, etc. Follow these steps when decontaminating this equipment:

- Set up a centralized decontamination area, if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.
- Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination pads shall be upwind of any areas under investigation.
- Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports. The objects to be cleaned shall be at least 2 feet above the ground to avoid splashback when decontaminating.
- Using soap and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
- If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.
- Using a suitable sprayer, rinse the equipment thoroughly with analyte-free water.
- Remove the equipment from the decontamination area and place in a clean area upwind to air dry.
- Record equipment type, date, time, and method of decontamination in the appropriate logbook.
- After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

- Set up a decontamination line on plastic sheeting. The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment. At a minimum, clean plastic sheeting must be used to cover the ground, table, or other surfaces that the decontaminated equipment is placed for drying.
- Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.
- Wash the items with potable water and soap using a stiff brush as necessary to remove particulate matter and surface films. The items may be steam cleaned using soap and hot water as an alternative to brushing. **Note: Polyvinyl chloride or plastic items shall not be steam cleaned.** Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.
- Thoroughly rinse the items with potable water.

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- If sampling for metals, thoroughly rinse the items with an acid solution (e.g., 10 percent nitric acid) followed by a rinse using analyte-free water. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using analyte-free water. The specific chemicals used for the acid rinse and solvent rinse phases shall be specified in the work plan. The acid rinsate and solvent rinsate must each be containerized separately. Acids and solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health affects (e.g., skin burns, irritation to the eyes and respiratory system). Appropriate personal protective equipment must be worn when using these chemicals. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping these chemicals.
- Rinse the items thoroughly using organic-free/analyte-free water.
- Allow the items to air dry completely.
- After drying, reassemble the parts as necessary and wrap the items in clean plastic wrap or in aluminum foil.
- Record equipment type, date, time, and method of decontamination in the appropriate logbook.
- After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable personal protective equipment. Place the contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. Refer to site-specific plans for labeling and waste management requirements.

5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

- Set up the decontamination area and separate "clean" storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up four containers: the first container shall contain dilute (nonfoaming) soapy water, the second container shall contain potable water, the third container shall be empty to receive wastewater, and the fourth container shall contain analyte-free water.
- The pump shall be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Place the discharge outlet in the wastewater container above the level of the wastewater. Pump soapy water through the pump assembly until it discharges to the waste container. Scrub the outside of the pump and other wetted parts with a metal brush.
- Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
- Move the pump intake to the analyte-free water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes shall be required.
- Decontaminate the discharge outlet by hand, following the steps outlined in Section 5.3.
- Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices shall be covered with aluminum foil to prevent the entry of airborne contaminants and particles.
- Record the equipment type, serial number, date, time, and method of decontamination in the appropriate logbook.

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5.5 Instrument Probe Decontamination

Instrument probes used for field measurements such as pH meters, conductivity meters, etc. shall be decontaminated between samples and after use with analyte-free, or better, water.

5.6 Waste Disposal

Refer to site-specific plans and SOP 2-2 for waste disposal requirements. The following are guidelines for disposing of wastes:

- All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions shall be generated, each type of waste shall be contained in separate containers.
- Unless otherwise required, plastic sheeting and disposable protective clothing may be treated as solid, nonhazardous waste.
- Waste liquids shall be sampled, analyzed for contaminants of concern in accordance with disposal regulations, and disposed of accordingly.

6.0 Restrictions/Limitations

Nitric acid and polar solvent rinses are necessary only when sampling for metals or organics, respectively. These steps shall not be used, unless required, because of the potential for acid burns and ignitability hazards.

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with your EPA region, state, and client for approved decontamination solvents.

7.0 References

American Society for Testing and Materials. 2002. *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites*, ASTM D5088-02. January 10.

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TSOP 4-6
HYDRAULIC CONDUCTIVITY TESTING

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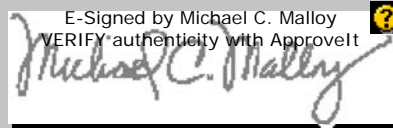
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1.0 Objective

Selected monitoring wells are used to approximate local hydraulic conductivity using either rising-head or falling-head slug test methods. The objective of this standard operating procedure (SOP) is to define requirements for conducting and analyzing in situ hydraulic conductivity (slug) tests in small, developed wells.

2.0 Background

2.1 Definitions

Slug Testing - A rapid and easy means of estimating the hydraulic conductivity of an aquifer. If the thickness of the aquifer is known, then the transmissivity can also be determined. Slug testing is accomplished by adding (or removing/displacing) a known volume to (or from) the monitoring well to create a rapid rise (or fall) in water level. Water levels are then measured as the water level in the well returns to static (pre-test) conditions.

Slug Bar - A weighted cylinder that is used in displacing water in a well of known volume. A bailer may be used in place of a slug bar under low-recharge aquifer conditions.

Pneumatic System - A system that uses an air pump, compressor, or compressed air cylinder to increase the air pressure in the well, which is sealed with an air-tight cap that has ports through which the compressed air is introduced and a water level indicator or pressure transducer can be inserted. This displacement method is commonly employed in high transmissivity aquifers, where sufficient displacement is difficult to achieve using a slug bar or bailer. A pneumatic system can also be used to lower the water level. In all cases, the rate of water level recovery is then measured using a pressure transducer and data recorder or a water level meter and stopwatch (the former method is preferable in most environments). Data, as displacement-time pairs, are then graphed and used in equations to determine hydraulic conductivity.

2.2 Associated Procedures

- CDM Federal SOP 1-5, *Groundwater Sampling with Bailers*
- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 2-6, *Handling Investigative-Derived Waste*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-3, *Well Development and Purging*
- CDM Federal SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- CDM Federal SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

Advantages of slug testing over pump testing include the fact that little or no contaminated water is produced requiring containment and disposal as well as that several areas can be tested in a relatively short period of time. A disadvantage of slug testing is that the resulting estimate of hydraulic conductivity is limited to a small volume of the aquifer around the tested well and care must be taken in extrapolating the results from one well to other areas or intervals of the aquifer.

If possible, when designing the field program or considering in which interval to place a well screen, try to screen only one formation type. If a well is screened across more than one formation (such as fine sand and coarse sand or overburden and bedrock), it will not be possible to attribute the slug test response to either formation with any accuracy.

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3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel have been trained in conducting slug tests and for ensuring that slug tests are conducted in accordance with this procedure.

Field Team Leader - The field team leader is responsible for performing slug tests in accordance with this procedure and for verifying that the data collected are adequate and of high quality. The project field geologist shall perform a field calculation to check data quality.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

The following equipment shall be used when performing a rising or falling-head slug test in a monitoring well. Site-specific conditions may warrant the use of additional equipment.

- Pressure transducer and data recorder, if data are to be automatically recorded (recommended) and manufacturers' instructions
- Laptop or hand-held computer for downloading and viewing data (field printer optional)
- Water level measuring device
- Stopwatch, if measurements collected manually (not recommended)
- Slug device of known volume
- Rope or wire
- Duct tape
- Field logbook
- Decontamination equipment and supplies
- Data on the construction of the well: depth to screen, screen length, well drilled diameter, riser diameter, height of sandpack above screen and length of riser above ground surface

Note that the well construction data shall be used so that the slug test data being collected are appropriate and of acceptable quality. Additional information (e.g., distance from screen to confining layer) may be necessary to analyze the data and determine the hydraulic conductivity. Data analysis is not covered under this procedure.

The slug bar shall be constructed of plastic, such as polyvinyl chloride (PVC), or metal such as aluminum or steel (depending upon the chemical environment in the well) and have no buoyancy. For example, a standard slug is constructed with a PVC pipe filled with sand and capped at both ends. The slug bar shall be of sufficient size to cause a recommended minimum of 2 feet of displacement in a well. A slightly lesser or greater head change is acceptable so long as a sufficient response curve is recorded that can be applied in a subsequent analysis. For a 2-inch diameter monitoring well, the slug bar shall be no more than 1.5 inches in diameter and a minimum of 5 feet long. For a 4-inch diameter well, the slug bar shall be no more than 3 inches in diameter and a minimum of 5 feet long. The slug bar shall be securely fastened to a nylon rope or braided metal wire.

A standard sampling or well development bailer may be used in place of the slug bar, as long as the volume of water displaced by the bailer is sufficient to change the water level in the well a minimum of 2 feet. If the bailer is to be used for a falling-head test, it shall be filled with analyte-free water so that the bailer will not have any buoyancy.

5.0 Procedures

5.1 Preparation

The following steps must be followed when preparing for slug testing:

- Lay plastic sheeting around the wellhead. Arrange needed equipment and decontamination materials on the sheet.
- Put on personnel protective clothing, as specified in the site-specific health and safety plan.
- Open the protective casing locking lid and vented riser caps following the procedures outlined in SOP 1-6. Note the physical condition of the well, including damage, deterioration and signs of tampering. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor readings with a suitable organic vapor screening device.

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- Measure and record the static water level, the depth to the bottom of the well and inside diameter of the well casing. Record these data in the appropriate logbook.
- If using a pressure transducer and data logger (transducers with built-in data loggers are commonly used for slug tests), lower the pressure transducer into the well to a sufficient depth so that the transducer will be below the maximum depth reached by the bottom of the slug bar or other displacement device. If necessary, calibrate the transducer as specified by the manufacturer. Allow the transducer to temperature equilibrate in the well for approximately 15 minutes (or as recommended by the manufacturer) after insertion and before any calibration or test procedure to ensure that it will accurately record water level changes. Make sure that the transducer is not placed below its maximum operating depth, or it will not be able to detect any change in pressure. For example, pressure increases 1 pound per square inch (psi) per 2.3 feet of head; therefore, a 10 psi transducer will function to a depth of 23 feet below the water level in the well.
- Secure the pressure transducer cable to the well riser or casing using duct tape. The transducer cable shall lay flat along side the well riser, so that disturbance by the slug bar will be avoided.

Note: Do not kink the transducer cable, otherwise the pressure equalization vent tube in the cable will be damaged and the transducer will not function properly.
- Allow the water level in the well to recover to static after emplacement of the pressure transducer, before starting the test. Measure and record this water level.
- Program the data logger to record logarithmically, with a maximum time interval of no more than 1 minute between readings. If the formation is expected to have low hydraulic conductivity, the maximum interval between readings can be set to a longer time interval, such as 10 minutes.
- Confirm and/or set the transducer and logger parameters as recommended by the manufacturer. This task may also be performed before placing the instrument in the well.
- Determine the distance from the top of the well riser to the water surface in the well and add 1 foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of 1 foot when it is placed in the well. A loop shall be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. When inserted into the well, the slug bar shall be a distance (more than 1 foot) above the transducer to avoid disturbing the measuring device.
- If depth readings are to be recorded manually (this procedure is not recommended but may be used in formations suspected of having low hydraulic conductivity, less than 1 foot per day), readings shall be taken every 10 seconds for the first minute of the test, every 30 seconds for the next 4 minutes and every minute until 10 minutes. Thereafter, readings shall be taken every 5 minutes for the duration of the test. If the well has not recovered within 1 hour, readings shall be taken every 0.5 hours until 6 hours and 1 hour every hour thereafter. This process will require two personnel during the first 10 minutes of the test: one to act as time keeper/data recorder and one to measure depth to water in the well.

5.2 Standard Displacement Slug Tests

5.2.1 Falling-Head Slug Test Procedure

This test can only be conducted in wells whose screens are fully submerged, otherwise, displaced water will be introduced into the unsaturated zone and recovery rates will be due to flow in both the unsaturated and saturated zones. All slug test analytical procedures assume flow in the saturated zone only. The following steps must be followed when performing falling-head slug tests:

- Place the slug or bailer in the well until the bottom of the displacement device is no more than 6 inches to 1 foot above the water level in the well. The person holding the device shall be holding the rope or wire by the rod or stick described in Section 5.1, ninth bullet.
- Switch on the data recorder, or set the water level meter probe near the level at which water is expected to rise.
- To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly lower the displacement device into the well until the stick or rod is resting horizontally on top of

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the well riser. The slug bar shall not be dropped, to minimize sloshing in the well. The data logger is turned on immediately prior to the slug bottom entering the water.

- Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.
- Record the time of test completion and file name in the logbook.
- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity) the project manager shall be notified and a determination on the well test shall be made.
- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing shall be taken to designated disposal containers.
- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

Note: Both rising- and falling-head slug tests may be carried out in the same operation by first measuring the rate of water level fall immediately after slug insertion, then measuring the rate of water level rise after slug withdrawal. Be sure that the well has recovered to the static water level before conducting the rising-head test. If using a data logger, the recovery tests needs to be set up and run as a separate test.

5.2.2 Rising-Head Slug Test Procedure

The steps for a rising-head test are essentially the same as those for a falling-head test. In a well screened across the water table, a rising-head test is the only test that is valid. The following steps must be followed when performing rising-head slug tests:

- Lower the slug bar or bailer of known volume into the well until it is fully submerged. Allow the well to re-equilibrate to static water level. In formations of suspected low hydraulic conductivity, re-equilibration may take several hours or overnight. In such cases, it is suggested that the displacement device be placed in the well at the end of a field day and the test conducted the following day.
- Turn on the data recorder, if used, or verify that static water level has been re-established with a water level meter.
- To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly and smoothly raise the displacement device from the well until the bottom of the slug bar is above the water level in the well. The data logger is turned on or manual measurements commence at the moment the slug bar is raised and before it (or any portion of it) is removed from the water. If a data logger is being used, the slug bar wire or rope shall be secured to the well casing or riser for the duration of the test and only removed from the well after the test has been completed, to avoid disturbing or dislocating the pressure transducer.
- Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

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- Record the time of test completion and file name in the logbook.
- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity), the project manager shall be notified and a determination on the well test shall be made.
- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing shall be taken to designated disposal containers.
- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

5.3 Pneumatic Rising-Head Tests

This test can be performed in aquifers of high hydraulic conductivity that are expected to respond very rapidly to slug displacement. It can only be performed in wells where the screen is substantially below the water table, otherwise, increased air pressure in the well casing will be able to bleed off to the unsaturated zone through the well screen and the test will not be successful.

5.3.1 Required Equipment

In addition to the required equipment outlined in Section 4.0, the following equipment shall be used when conducting a pneumatic rising-head slug test.

- Minimum 30-psi rated transducer and data logger
- Electric water level indicator with on/off switch
- Pressure-tight "tree" assembly, as described below
- Short length (6 inches) of flexible rubber hose whose inside diameter is the same as the outside diameter of the well riser
- Two 2- or 4-inch diameter hose clamps
- Compressor, air pump, or compressed air tank with hose and appropriate adapters

The pressure-tight tree assembly is a device placed on the top of the well that will accomplish the following:

- Form a pressure-tight seal between the well and the atmosphere
- Allow the injection of compressed air into the well via an air hose connected to the pump, compressor, or air supply
- Provide a pressure-tight passage for a pressure transducer cable and a water level meter
- Allow for rapid well depressurization

The tree is illustrated in Figure 1. If the top of the riser is threaded, the device may be screwed onto the riser if the threads are compatible (Teflon™ tape shall be used to ensure a good seal). If the threaded end of the riser has been cut off, a slip coupling will need to be placed over the base of the tree and the top of the riser. A small length of flexible rubber hose the same inside diameter as the outside diameter of the coupling will need to be slipped over the coupling and secured in place with tightly closed hose clamps to form a pressure-tight seal between the riser and the well.

The simplest method for providing access through the tree for the pressure transducer cable indicator is to use a modified standard large diameter black rubber cork. A hole that is the same diameter as the cable shall be drilled through the cork's axis and a vertical slit shall be cut radially from the hole to an edge of the cork. The pressure transducer cable shall be threaded through the hole and the water level indicator tape shall be placed flat in the slit. The cork shall be firmly placed in the top of the tree to form a pressure-tight seal. To ensure that the cork does not pop out while the well is under pressure, it can be secured in place with duct tape or a friction fit plastic cap placed over the cork and onto the tree.

The tree will have a standard ball valve with an inside valve orifice diameter no less than the diameter of the well riser as shown in Figure 1. In addition, a pressure-tight coupling (swage-loc, quick-connect, or Schrader valve) will be attached to the side of the tree to act as a compressed air inlet.

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5.3.2 Preparation

Preparation procedures for the pneumatic test are similar to those for the standard slug bar displacement test, with the exception that an electronic data logger is a necessity for this procedure.

5.3.3 Pneumatic Slug Test Procedure

- Install the test tree to the top of the well, using a method appropriate to the type of riser present (threaded or unthreaded). Make sure that the seal to the riser top is pressure-tight.
- Lower the pressure transducer into the well through the top of the tree to a minimum of 10 feet below the water table. The pressure transducer shall be rated no less than 30 psi. Allow the transducer to equilibrate at least 15 minutes before initiating any calibration or test procedure.
- Turn on and insert a water level indicator into the well to approximately 5 feet depth below the water table. Turn off the indicator.
- Secure the water level indicator and pressure transducer to the test tree using the rubber cork described in Section 5.3.1. Insert the transducer cable into the hole in the rubber cork via the slit and place the water level indicator tape flat in the slit. Place the cork firmly in the top of the tree so that no gaps are left in the cork. Place small strips of duct tape over the assembly to ensure that the seal is airtight and that the cork cannot loosen when the well is pressurized.

Note: During this procedure, do not kink the transducer cable or the pressure equalization vent tube in the cable will be damaged and the transducer will not function.

- Connect the pressure transducer to the data logger and calibrate the system according to manufacturer's instructions. Set the data logger to record logarithmically with a maximum recording interval of no more than 1 minute. Set the logger to record relative change in head only.
- Connect the air hose to the compressed air supply, pump, or compressor and to the tree. Make sure the ball valve is securely closed.
- Turn on the water level indicator and start feeding compressed air to the well. When the water level in the well has been depressed sufficiently, the water level indicator submergence tone will stop sounding. The pressure required shall be no more than 2 or 3 pounds over atmospheric pressure.
- Simultaneously open the ball valve and activate the data logger. Open the ball valve quickly so that the pressure is released at once.
- In highly permeable aquifers, the water level shall recover to pre-test water levels within a few seconds. Full recovery shall be accomplished in no more than 1 minute. In any event, do not stop the test until a minimum of 90 percent recovery can be confirmed with the data logger.
- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity) the project manager shall be notified and a determination on the well test shall be made.
- Record the time of test completion and file name in the logbook.
- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing shall be taken to designated disposal containers.
- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost.

6.0 Data Reduction and Analysis Procedures

6.1 General

The following slug test data reduction procedure and report is recommended.

- All raw data shall be printed out and listed as an appendix to the analysis report.
- All data shall be plotted using the graphing method of the accepted analytical solution. These plots shall be included as an appendix to the analysis report.
- All well geometry data shall be tabulated and included in the analysis report. Most of these data must be known before the start of testing, except for items related to the water level in the well at the time of testing. The purpose of this tabulation is to ensure consistent calculation of all variables required in the data analysis, make input into a data analysis computer program an easier task, and to make technical review of the analyses and input values easier. This table shall include the following items for each tested well or piezometer (the list of items may vary depending on the analytical method employed):
 - Well ground surface elevation
 - Well reference elevation (i.e., top of riser)
 - Depth to static water level at start of test
 - Elevation of static water level at start of test
 - Depth to top of screen or open interval from ground surface or top of casing
 - Depth to bottom of screen or open interval from ground surface or top of casing
 - Elevation of top of screen or open interval
 - Elevation of bottom of screen or open interval
 - Depth to base of aquifer (if available)
 - Elevation of base of aquifer (if available)
 - Aquifer saturated thickness
 - Depth to top of screen or open interval relative to the top of the aquifer
 - Depth to bottom of screen or open interval relative to the top of the aquifer
 - Length of saturated well screen
 - Length of saturated riser
 - Diameter of well riser and screen (or open interval)
 - Diameter of borehole
 - Grain-size of filter pack
- The report shall include a detailed description of the data collection procedures and test methods.
- The report shall include a detailed listing of all analysis results.
- When reviewing the data for analysis, note that if the water level recovered to the static level (or close to it) before the test was stopped, only the data before 100 percent recovery shall be included in the data plot. Plotting 100 minutes of data when the recovery occurred rapidly (e.g., 30 seconds or 2 minutes) will make analysis of the actual response very difficult and often lead to a substantial underestimate of the formation hydraulic conductivity. Raw data plots shall also be examined for evidence of sloshing of the water level in the well caused by insertion or removal of the slug bar. In most cases, these early data points can also be removed from the data set and time values reset to the new starting point represented by the remaining data. This evaluation is shown on Figure 2. The data may also be removed using common software packages developed for analyzing slug tests.

6.2 Review and Analysis of Data

Slug test response generally falls into three categories illustrated on Figure 3. Overdamped or normal response occurs where the well recovers to static level without exceeding that level. Critically damped response occurs where the well recovers to static level and the water level flows above (rising-head test) or below (falling-head test) then recovers to static in a sinusoidal manner within one cycle, as shown in Figure 3. The third category is underdamped harmonic oscillatory response, where the water level in the well oscillates around the static water level as a sine wave of decreasing amplitude.

Slug test data are recommended to be analyzed with computer software; however, data may also be analyzed manually. The CDM groundwater modeling tool kit contains Aquifer^{WIN32}, which is a program that may be used for analyzing slug test data. Other programs are also available. Software packages are useful since they can be used to manage a significant

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amount of data in short time periods and contain many different confined and unconfined slug test solutions. The trained user can use these benefits to generate detailed response curve graphs, precise hydraulic conductivity values, and insights into the hydrogeologic framework near the well. Regardless of the analytical method employed or whether the data is analyzed manually or by computer, the analyst shall review the original technical paper or textbook summary of the method to understand the mechanics and assumptions underlying the method before attempting any analysis.

Slug test data analyses and hydraulic conductivity calculations shall be performed by an experienced professional. Data analysis and parameter calculations are beyond the scope of this SOP and, therefore, are not discussed here.

7.0 Restrictions and Limitations

In wells in which the static water level and water levels induced during testing are above the top of the screened or open hole interval, both rising-head and falling-head tests shall be conducted to provide a redundancy check of results. However, in most cases, rising-head tests provide more consistent data, less subject to sloshing of the water level due to displacement by the slug bar than is often observed in falling-head tests. Falling-head slug tests are invalid in wells where the static water level is at or below the top of the screened or open-hole interval.

Regardless of which testing method is used, it is recommended that the hydraulic conductivity testing be performed three times in each well, if time constraints such as recovery time or the project schedule will allow multiple tests. The purpose of multiple testing is to demonstrate the precision of the test results. Ideally, the test results will be similar, which results in an increased level of confidence in the data. In addition, if one of the data sets is bad, there is additional data available for analysis.

8.0 References

American Society for Testing and Materials. 2002. *Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*.

Environmental Simulations, Inc. 2003. *Guide to Using Aquifer^{WIN32} – WinFlow-WinTran*.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

_____. 2001. Region 4. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*.

Figure 1
Pneumatic Slug Test "Tree" Schematic

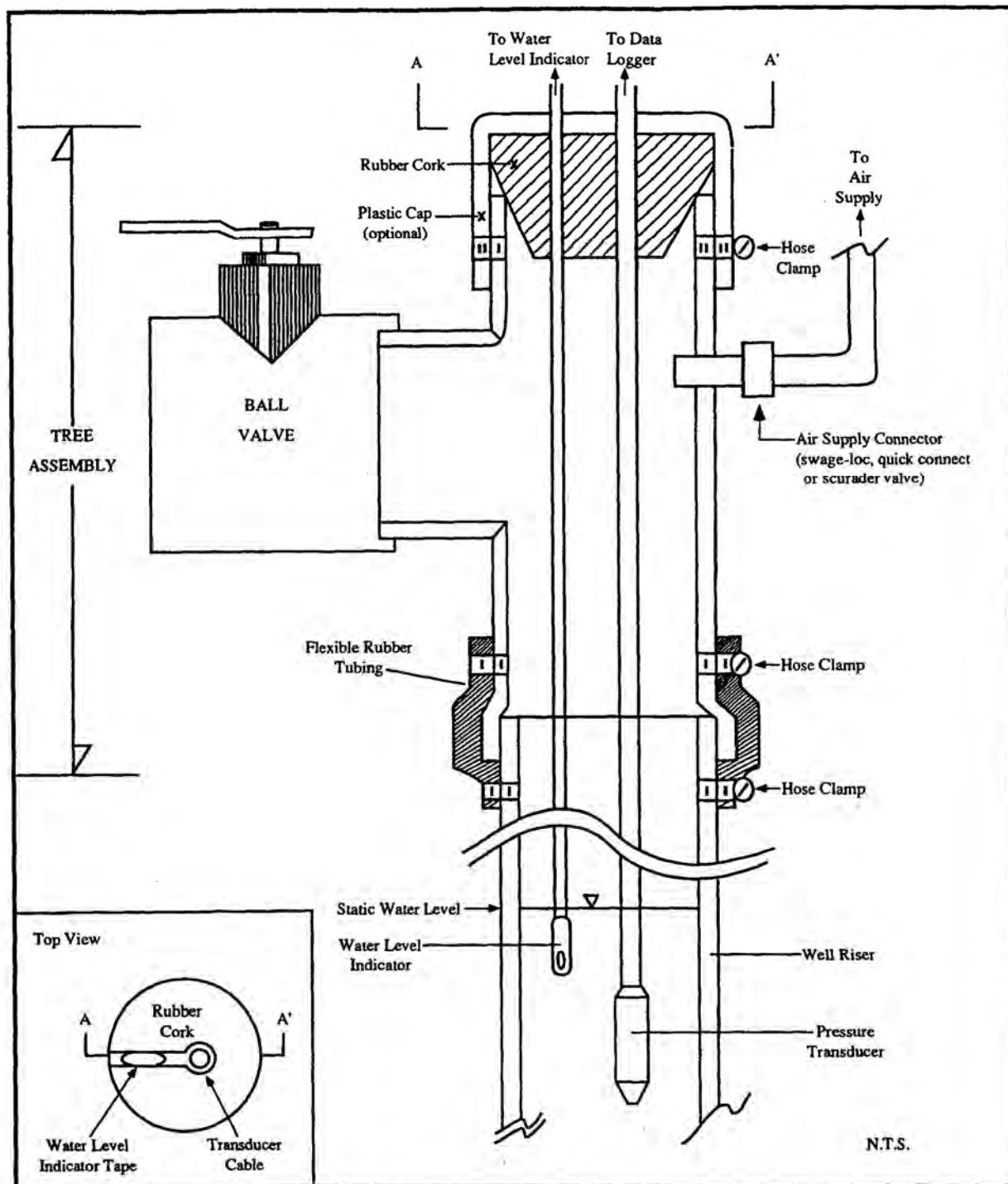


Figure 2
Deletion of Nonessential Data

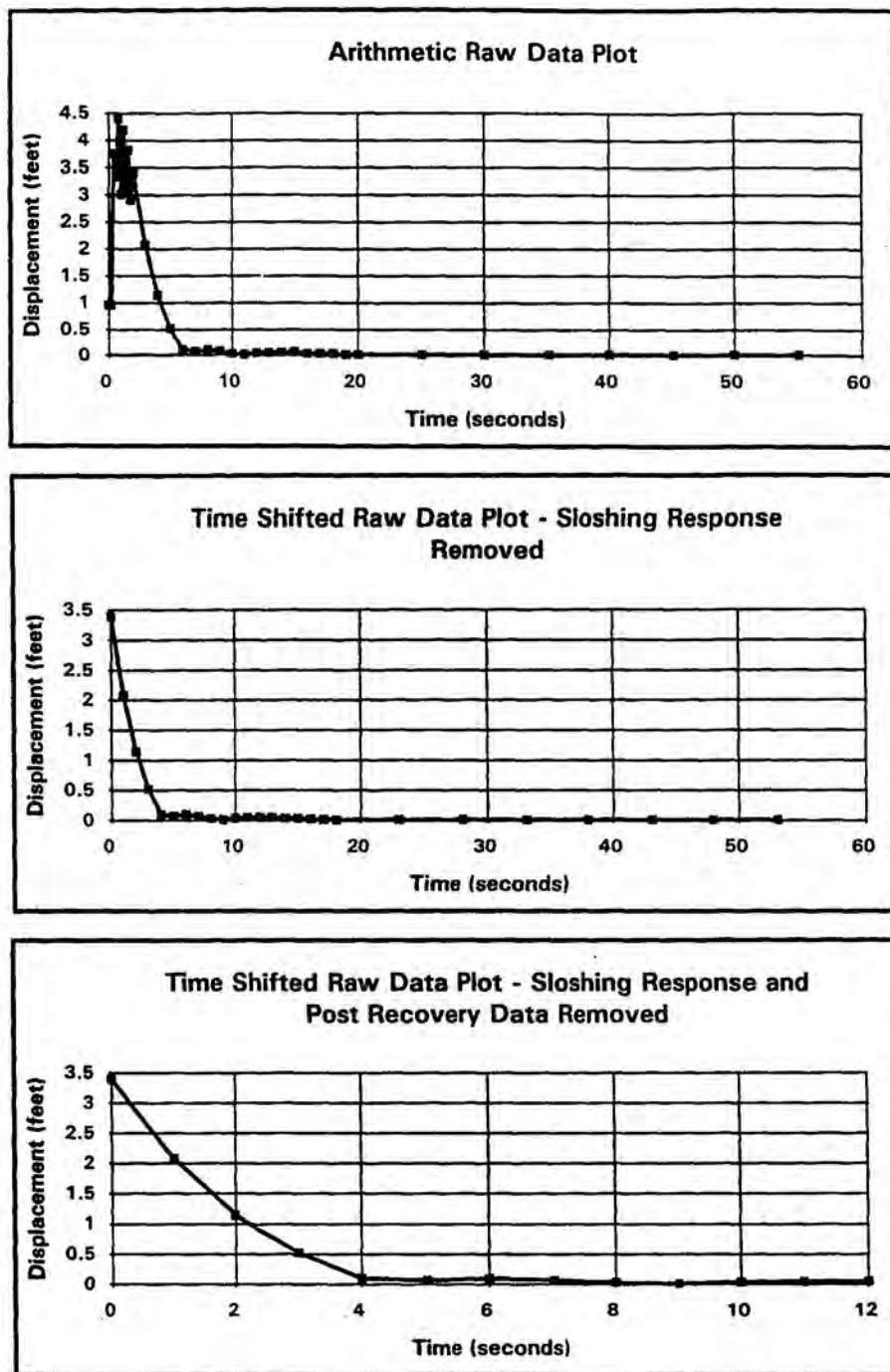
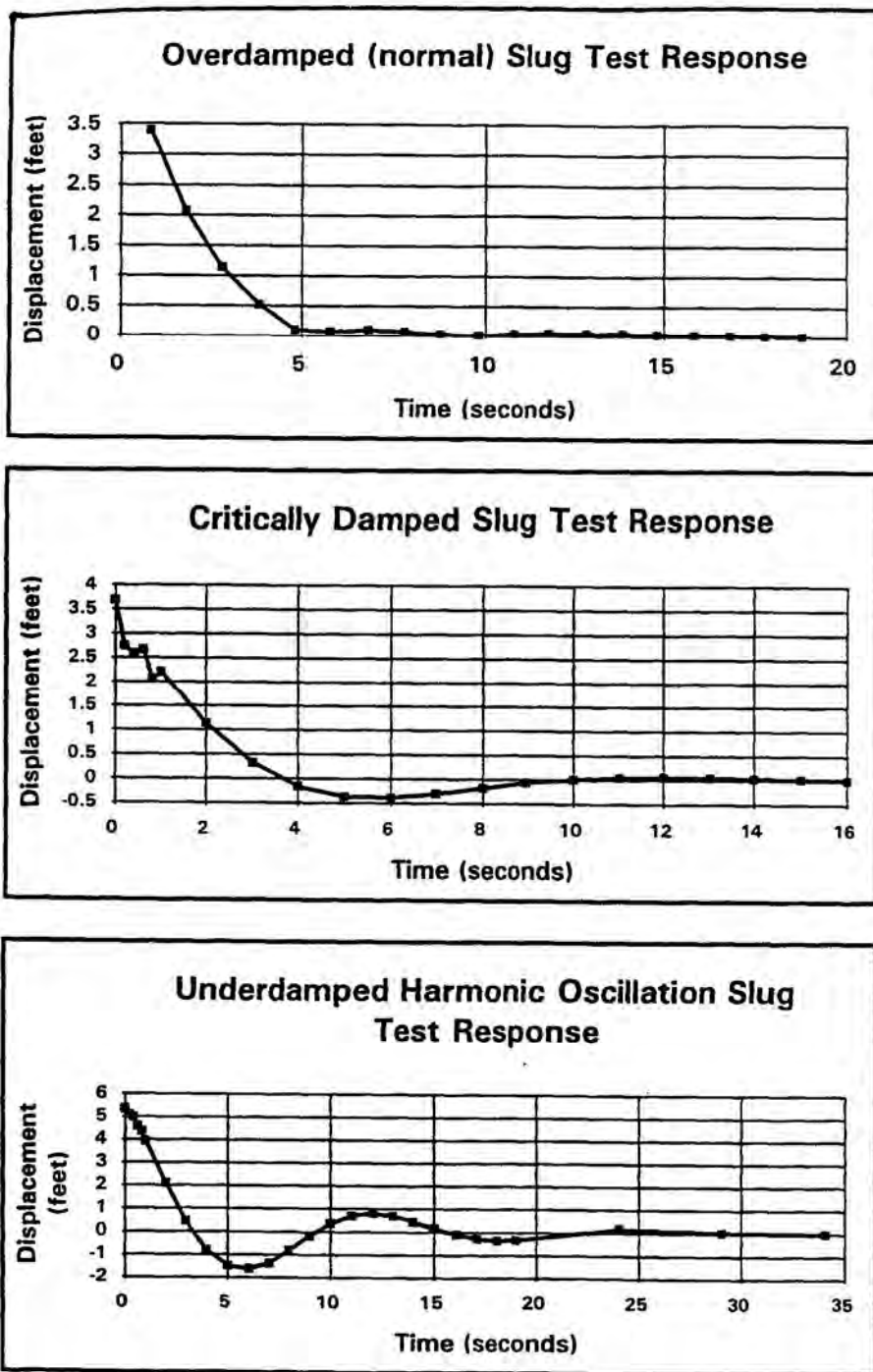


Figure 3
Typical Slug Test Responses



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ENVIRONMENTAL DATA MANAGEMENT

Environmental Data Management

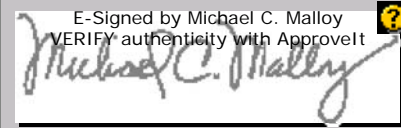
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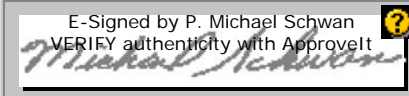
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VERIFY authenticity with ApproveIt


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1.0 Objective

The objective of this standard operating procedure (SOP) is to provide instruction to data managers, technical staff, and project managers in preparing an environmental project data management plan. The data management plan identifies and documents a project's requirements and responsibilities for managing and using environmental information. Details determined and provided in the data management plan must clearly define:

- Data types the project will generate and use
- Responsibilities for activities associated with information management
- How the project data will be managed
- When data transfers will occur and who will provide and receive data

Additionally, this SOP defines the technical approach for data management activities associated with the collection and analysis of environmental data.

2.0 Background

The data management plan must be completed at the beginning of the project lifecycle. This ensures that the necessary environmental data management systems and personnel are identified and in place before the initiation of data collection. Reviews and updates of the data management plan must also be completed as necessary.

The data management plan only addresses the management of a project's environmental information. Environmental information includes electronic and hardcopy records that document environmental processes and conditions and are used to support the project objectives related to environmental and remedial decisions. Information generated by the project activities (e.g., chemical, physical) and information obtained from outside sources (e.g., historical data) are managed within the scope of the data management plan. Information such as human resources and financial records are not within the scope of the data management plan.

Project managers, technical staff, and data coordinators have the responsibility for developing the data management plan. Additional staff (e.g., field team leaders, data users) shall also be involved in the data management plan generation as necessary. The minimum project data requirements will depend on the statement of work for individual projects. The project team shall work together to identify project data management requirements, define the environmental data collection and handling process, and define the project data management responsibilities. The process to generate a data management plan is provided in Section 4.0.

2.1 Associated Procedures

All SOPs used to collect environmental data are subject to the procedures and processes presented in this SOP. These include:

- CDM Federal SOP 1-1, *Surface Water Sampling*
- CDM Federal SOP 1-2, *Sample Custody*
- CDM Federal SOP 1-3, *Surface Soil Sampling*
- CDM Federal SOP 1-4, *Subsurface Soil Sampling*

- CDM Federal SOP 1-5, *Groundwater Sampling Using Bailers*
- CDM Federal SOP 1-6, *Water Level Measurement*
- CDM Federal SOP 1-7, *Wipe Sampling*
- CDM Federal SOP 1-8, *Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA® Canister*
- CDM Federal SOP 1-9, *Tap Water Sampling*
- CDM Federal SOP 1-10, *Field Measurement of Organic Vapors*
- CDM Federal SOP 1-11, *Sediment/Sludge Sampling*
- CDM Federal SOP 2-1, *Packaging and Shipping Environmental Samples*
- CDM Federal SOP 3-1, *Geoprobe Sampling*
- CDM Federal SOP 3-2, *Topographic Survey*
- CDM Federal SOP 3-4, *Geophysical Logging, Calibration, and Quality Control*
- CDM Federal SOP 3-5, *Lithologic Logging*
- CDM Federal SOP 4-1, *Field Logbook Content and Control*
- CDM Federal SOP 4-3, *Well Development and Purging*
- CDM Federal SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- CDM Federal SOP 4-6, *Hydraulic Conductivity Testing*

3.0 General Roles and Responsibilities

A general description of roles and responsibilities associated with environmental data management is provided below. It shall be understood that not all roles listed below will be required on all projects and that one person may perform multiple roles.

Project Manager - The project manager has the overall responsibility for completing the project. With respect to data management, this involves directing the project team in identifying existing sources of data, identifying the specific project study parameters (e.g., scope of the project), and selecting an effective data collection approach. Additionally, the project manager ensures that data management requirements are effectively communicated in subcontractor statements of work.

Technical Leader - The technical leader serves as the single point of contact for technical issues. This person provides support during the planning, implementation, and reporting of the project.

Project Team - The project team consists of technical and support staff (e.g., data management and administrative staff) who completes various tasks on the project. The project team is responsible for the development of requirement documents (e.g., sampling plans) and ensuring that client contractual requirements are met.

Field Team Leader - The field team leader supervises field teams during planning and implementation of field data collection. The field team leader ensures that field activities are documented according to project-specific requirements, reviewed as required, and that deviations are tracked and justified.

Field Team - The field team consists of individuals who perform activities detailed in the project-specific requirement documents. Field team responsibilities include recording field activities and information as required by the project-specific planning documents. Quality assurance reviews of procedure implementation are completed by a qualified field team member. Quality assurance reviews include ensuring samples are collected as required, calibrations are completed correctly, and that all information is recorded as required.

Data Management Team - The data management team consists of a data manager and data support staff. The data manager is responsible for developing and implementing the project data management plan and ensuring that requirements specified in the data management plan are met. The data manager ensures that existing data and new data generated during the course of the project are incorporated into the project files and applicable databases. The data manager also identifies and obtains appropriate data management training for the project team. The data manager is responsible for overseeing the data support staff.

Data support staff are responsible for entering environmental project data into the project files or database and ensuring that all information is entered accurately. Data support staff also work with the field teams and data users to ensure that data collection is complete and access to the data is appropriate.

Laboratory Coordinator - The laboratory coordinator develops the project-specific analytical statement of work. Analytical methods, detection limits, laboratory quality control requirements, and deliverable requirements must be detailed in the statement of work. The laboratory coordinator also communicates with the data manager to ensure that hardcopy and electronic deliverable formats are specified and meet project requirements.

Data Validation Coordinator - The data validation coordinator is responsible for developing the data validation process specific to the project requirements and is responsible for supervising data validation staff. Included in this process is the approach to verifying that analytical data and field data are complete and accurate, have fulfilled the requested analyses, and are in concurrence with the contract requirements. If discrepancies arise, the data validation coordinator interfaces with the laboratory for resolution. If data validation occurs via a subcontractor, the data validation coordinator is responsible for the development of the subcontractor statement of work and supervision and review of the subcontractor's work.

Data validation staff are responsible for ensuring that analytical data and field data are accurate according to a project-specific set of criteria, including the evaluation of quality control samples to ensure analyses are performed within specified control limits. All validation issues must be identified and corrected. Qualifiers may be assigned to the data to indicate concerns about usability.

Data User - Data users are members of the project team who require access to project information for project decisions and to prepare deliverables. The data user is responsible for documenting information used (e.g., geographic information system [GIS] coverage, database queries, statistical analysis completed) to generate any data deliverables (e.g., data tables, maps). This requirement ensures that deliverables may be reproduced in the future using an identical process. Additionally, the data user is responsible for determining whether or not the data used meet their specific usability requirements.

Note: Responsibilities may vary from site to site. Therefore, all team member responsibilities shall be defined in a work plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Data Management Plan

This section describes the process to complete preparation of a project data management plan. The data management plan must be completed early in the life cycle of a project to ensure that the necessary and appropriate data management systems and personnel are identified and in place before a project begins to generate data. The data management plan identifies and documents the project requirements and responsibilities for managing and using environmental information. The data management plan must provide enough detail to clearly define:

- The types of data the project will generate and use
- Responsibilities for information management activities and procedures to follow
- How the project will manage its data
- When data transfers will occur and who will provide and receive data

4.1 Data Management Plan Outline

The project manager, data manager, and technical leader will evaluate project and client requirements to prepare the data management plan. The following outline shall be customized to meet the project-specific requirements. Additionally, as the project evolves over time, the data management plan must be reviewed and updated periodically to ensure that it suitably meets modifications to the project requirements.

Section 1 - Introduction

- Briefly describe project objectives
- Briefly describe data quality and management objectives
- Briefly describe data management plan objectives and organization
- Summarize the types of data required by the project
- Summarize the data management activities

Section 2 - Data Sources and Needs

- Identify the project data needs (e.g., internal sources, external sources)
- Identify data collection formats (e.g., field forms to be used, GIS coverage)

Section 3 - Data Management Team Organization

- Present roles and responsibilities
- Identify lines of communication

Section 4 - Data Management Activities

- Project planning and setup and data flow process (e.g., sample locations and identification nomenclature, laboratory subcontracting)
- Field data collection (e.g., sample tracking, field data entry, historical data)
- Data validation, evaluation, and qualification
- Database entry and post qualification
- Data analysis and output (e.g., mapping format and specifications, data sharing, figure generation)
- Data quality assurance and quality control
- Data usability

Section 5 - Data Management and Geographic Information System and Process Administration

- Identify project data management and geographic information systems to be used
- Identify any project-specific systems to be used for analysis, modeling, or mapping
- Describe how the project will ensure that data, geographic, and analysis systems and processes are controlled (e.g., configuration change control, security)
- Project documentation and storage (records management)
- Quality control implementation (e.g., quality control of electronic documents, GIS software guidelines, other analytical software guidelines)

4.2 Data Management Plan Preparation

Data management plan development includes a seven-step process. Each of the steps involved in the process are annotated below. Critical issues of the data management plan are the definition of project activities, roles, and responsibilities related to data management.

- **Determine the Data Manager** - Every project must have a project data manager. The data manager is responsible for assisting in identification of data management and data record needs according to project and client requirements. The data manager will work with the project technical leader in the development of the data management plan.
- **Identify the Project Data Needs and Sources** - The data needs and sources will be determined during project scoping meetings and by discussions with the project team. The data types, sources, and uses must be considered when requirements are being defined. Identification of data types includes topics such as:
 - Maps
 - Field measurements
 - Inspection information
 - Sample media
 - Analyses
 - Locations
 - Quantity of samples
 - Quality for intended use
 - Observations

Data source considerations will include historical, project-generated, and other similar projects. Examples of data uses include modeling (contaminant contouring/transport, geospatial), regulatory compliance, remedial investigation, and risk assessment.

- **Identify Existing Database Requirements** - A requirement may exist that all project information shall be transferred into a pre-existing client database. Close coordination with the client data managers and review of guidance will provide information associated with specific requirements. These requirements will include specific data loading tools, submission file groupings, and data entry guidance.

- **Identify Records Management Requirements** - The project manager, data manager, and technical leader will identify the records management requirements. Additionally, they will identify the types and quantities of records that will be generated and determine what requirements are necessary for their transmittal to the client or central storage location. Records will consist of the guidance and planning documents (sampling plan, quality assurance plan) that detail how samples and data are collected, processed, evaluated, and used by the project.
- **Define Data Management Activities and Responsibilities** - This step details the data flow process for the project. Within this process, responsibilities for data collection, data transfer, updates, and maintenance are defined. A clear understanding of these responsibilities is critical to ensure that the technical activities of the project are completed efficiently and effectively. Section 5.0 of this procedure provides generic activity descriptions and responsibilities common to many environmental projects.

The data flow process must be reviewed by the project team to ensure completeness and project specificity. Small projects may allow one individual to complete several roles and responsibilities whereas large projects may require multiple personnel to complete one role. Project team understanding and comprehension of the activities and responsibilities are important to the efficient implementation of the overall data management program.

- **Determine Database Needs** - The project manager, data manager, and technical leader will determine the database needs and requirements. Project components to consider during this process are the complexity, types, and volume of data the project will generate; types, frequency, and detail of reports required; and required accessibility of the data. Based on these components and any other project requirements, a database need will be determined. Automation of the database shall also be considered during this step. Database automation consideration shall include factors such as:
 - Volume of data
 - Frequency that data will be received
 - Format of the received data (electronic or hardcopy)
 - Time constraints on data reports
 - Complexity of the data

After database needs have been determined, the project manager and data manager will identify appropriate personnel to support the data management process. Personnel identification support can include geographical information system specialists, laboratory coordinators, and data support staff. Additionally, the project manager and data manager must identify any training requirement appropriate to the project data management process.

- **Prepare the Data Management Plan** - Based on the decisions made in the preceding steps and the customized outline, the data manager and technical leader will prepare the data management plan.

5.0 Project Data Management Activities

This section identifies typical environmental data management activities in the context of a generic project lifecycle. It is unlikely that all activities presented will be implemented on a single project. Only activities applicable to project-specific data management requirements need to be implemented. The activities presented below have been grouped into three sections. Section 5.1 presents planning activities that will identify the project data needs, identify existing information, plan for project data collection, and identify data management requirements. Section 5.2 presents data collection activities, which include data management support that will provide for efficient field data and field sample collection, data processing, and reporting. Section 5.3 provides review and data use activities that include the evaluation of data quality and project reporting.

5.1 Planning Activities

Environmental projects are most commonly conducted to determine contaminant characterization, remedial design parameters, remedial action requirements, or to complete environmental monitoring of some type. Data generated from these activities are used as the basis for decisionmaking.

5.1.1 Project Scoping

Before making decisions on data management requirements, a complete understanding of the project is required. Completing a scoping exercise based on client requirements and available information is the first step in planning for development of data management requirements. The following activities are included in the project scoping exercise:

- **Project Definition** - The effort to define projects is highly variable and completely dependent on the complexity of the project. For example, the project may be defined specifically in the client statement of work (e.g., sample wells 1, 2, and 3 and analyze water for volatile organics) or may be iterative where a specific condition may require investigation with further refinement of the project scope based on the results and findings (e.g., delineate nature and extent of contamination). Some projects may also be defined by first determining what questions need to be answered to meet the project objective. Therefore, project scoping can be conducted in multiple phases. First, the project scope is initially determined based on limited information and data (such as the information provided in the client statement of work). Next, after the review of more detailed and specific information, the project may be defined more accurately. Some projects may go through a systematic planning process such as implementing the data quality objective (DQO) steps where contractor, client, and regulators are involved. Project definition serves as the method of focusing and developing a conceptual model of the project so that appropriate management tools can be identified. For example, for a project where characterizing the nature and extent of contamination is the objective, the conceptual site model will include determining the environmental setting, the area of contamination, the contaminants of concern, fate and transport of contaminants of concern, and potential human health and ecological risks associated with contaminants of concern.
- **Identify Historical Information** - Information may exist from previous investigations and similar projects within the project boundaries. This information can prove to be valuable in providing insight into operational processes, contaminants of concern, and environmental compliance issues as well as geographical information.
- **Project Scoping Meeting** - A project scoping meeting must be held to finalize the project objectives, project decisions, and project tasks necessary to meet the project objectives. The scoping meeting may include the project team members only or may also include clients, regulators, and other technical team members such as project engineers/geologists and risk assessors.
- **Implement DQOs** - During the scoping meeting, DQOs shall be discussed and resolved. The following seven step DQO process shall be implemented:
 1. State the problem
 2. Identify the goal of the study
 3. Identify information inputs
 4. Define the boundaries of the study
 5. Develop the analytic approach
 6. Specify performance or acceptance criteria
 7. Develop the plan for obtaining data
- **Project Data Requirements** - During the scoping meeting, project data collection needs shall be clearly identified in terms of data use, quantity, and quality. Additionally, decision criteria, acceptable levels of uncertainty, and acceptable levels of false positive and false negative decisions need to be established in accordance with applicable data quality objective guidance.

5.1.2 Acquiring Existing Data

Environmental data collected during previous investigations and studies can prove to be valuable with respect to descriptive information and contaminants. Historical information may contain details in areas such as environmental compliance, geographical data, and characterization investigations. Existing data shall undergo the same review and evaluation as any recently collected information. This review assists in ensuring the quality of data collected during the initial stages of the project. While a quality review of this data is advisable, obtaining the necessary quality control data is not always possible. Included in the process of acquiring existing data are the following activities:

- **Locate the Existing Data** - The project manager will define the criteria by which existing data will be considered relevant (e.g., time period). Based on these criteria and additional information potentially provided by the client, a file search will be completed. These data can include physical, chemical, and geographic information.
- **Document Existing Data** - Once existing data have been located and acquired, documentation of these data must be completed. These data will be transferred into the project data management files.

- **Evaluate Existing Data** - Data users will evaluate the existing data for relevance to the current project objectives and data requirements. An essential part of this step is to determine the quality and suitability of the existing data to the current project objectives and requirements. Existing data may have been collected for very different intended uses. After evaluation, the project team will determine which existing data are useful and applicable to the current project. Documenting and inventorying the evaluation and data selected for inclusion to the project files must then be completed.
- **Process Existing Data** - The data manager will incorporate the appropriate existing data into the project database. Processing the data includes converting information into common systems to be used for the project (e.g., common coordinate systems). All data processing steps completed during conversion and incorporation must be documented.

5.1.3 Project Data Collection Planning

Before starting this step, the project goals and data requirements must be defined to allow for the development of more detailed project plans. Included in the process of planning project data collection are the following activities:

- **Data Requirements** - Project data requirements need to have been developed during the previous project scoping activities. Types of data that will be required include site operations with respect to:
 - Hazardous substances
 - Disposal practices
 - Quantities of hazardous substances
 - Potential migration of contaminants
 - Site conditions
 - Historical and aerial photographs and base map data
 - GIS coverage of soils, geology, hydrogeology, and delineated contaminated plumes
- **Develop Project Work Plans** - All projects require that guidance documents be developed to describe in detail how the project objectives will be met. These guidance documents will range in complexity dependent on the project type, project complexity, and the project regulatory requirements. The guidance document must be developed using the level of detail required to enable any entity to implement it. Examples of projects requiring guidance documents include:
 - Remedial investigation/feasibility studies
 - Remedial design/remedial action
 - Engineering evaluation/cost analysis

Additionally, supporting plans and procedures may need to be developed to supplement the work plan. Examples of supplemental plans are:

- Sampling and analysis plans
- Quality assurance plans
- Health and safety plans
- Waste management plans
- **Develop the Laboratory Statement of Work** - The laboratory coordinator will prepare the laboratory statement of work specific to the project requirements determined in the project work plans. The laboratory statement of work must detail:
 - The number of samples to be sent for analysis
 - The analytical methods
 - Reporting limits
 - Laboratory quality assurance/quality control requirements
 - Data deliverable requirements

The statement of work must define the electronic data deliverable format and requirements and request an example from the laboratory to confirm requirements will be met. Additionally, the laboratory statement of work must define the data deliverable requirements necessary to ensure that validation and evaluation may be completed.

- **Develop Data Validation and Evaluation Criteria** - The data validation coordinator is responsible for developing the data validation and evaluation process. The data validation and evaluation process will document the approach to verify that project DQOs are achieved. The range of effort required to meet the project validation and evaluation needs

may range from none to very exhaustive, dependent on the client and project objectives. Validation and evaluation criteria may be modeled after national guidelines (e.g., National Functional Guidelines), client requirements (e.g., specific client work instructions or procedures), or a combination of both. Variables that are usually considered include:

- Sample preservation and holding times
- Calibration of instruments
- Blanks
- Laboratory quality control samples
- Field quality control analysis

The data validation and evaluation process will be included as a section in the project work plan or equivalent. If data validation and evaluation are completed by a subcontractor, the statement of work (detailing the project required process) will be developed.

5.2 Data Collection

The following data collection activities identify the data management team support and project team interactions that will ensure efficient field data and field sample collection, event documentation, data processing, and reporting.

5.2.1 Field Activity Preparation

After completing the work plan and detailed project plans, preparing for field activities is the next step. Preparing for field activities ensures that data and sampling processes for the project are complete and appropriate. Field preparation activities may include obtaining permits, surveying and marking sample locations, installing wells, and testing any required equipment. Data management team preparation activities include ensuring all data users have been trained and have access to the data management system, laboratory data deliverables can be transferred into the project database (laboratory test electronic data deliverables have been received and checked), project field forms have been created, and the records management requirements identified in the data management plan are established. Additional field preparation activities are detailed below.

- **Data Management Plan and Data File Management** - The data manager will ensure that the data management plan is implemented. Implementation of the plan must begin before collecting field data to ensure that the system developed is appropriate and functional. The data manager will also ensure that the data file management system is established before collecting field samples or measurements.
- **Site Survey** - The field team leader inspects the project site area for placement of sampling locations and equipment. These locations shall be documented on site maps and stored in the project files (hardcopy, GIS etc.). These identified locations shall be physically marked at the site with flagging, paints, stakes, etc.
- **Identification of Sampling Locations** - The sampling stations identified are differentiated by assigning a unique identifier to each location. Historical location identifiers must be confirmed and consistently used throughout the project. Geographic coordinates must then be obtained for each sampling location. The method of determining the geographic location shall be selected based on project accuracy requirements. Information used to select and document accuracy must be maintained. Examples of this information include the type of equipment, processing software, and accuracy reports.
- **Installation of Sampling Locations** - Sampling location installation will include the placement of:
 - Monitoring wells
 - Boreholes
 - Direct push locations
 - Cone penetrometer locations

Record and maintain the following information:

- Drilling and monitoring well construction information (e.g., borelogs, construction logs)
- Development logs
- Purging logs
- Associated measurements (e.g., air monitoring, water quality monitoring)

- **Instrumentation and Equipment** - After placement of the sampling locations, any required instrumentation and equipment must be installed. An inventory of the instrumentation and equipment must be maintained. Included in the inventory will be:
 - The type and manufacturer of the instrument and equipment
 - Calibration requirements
 - Identification numbers
 - Type of data the instrument will collect
- **Project Database Update** - All information and data collected during the preparation activities shall be captured in the project database. After these preparatory steps have been completed, the collection of environmental data will begin. The project data manager shall be kept current on sampling and data collection schedules and activities.

5.2.2 Field Data Collection

Depending on the type of project, field data may consist of several different types. Field data may consist of observations, checklists, photographs, or preliminary field screening analytical data. Any time field data collection activities are conducted, they must be planned and scheduled. Data entry items such as checklists, field logbooks, and field data forms must be generated during the planning stage to ensure that the required data are captured. Information and data collected during the field data collection activities must enable the project team members to recreate or reconstruct the events that occurred during the activity. Due to project data needs ranging from simple to complex, not all steps provided below will apply to all projects.

- **Schedule** - The project manager is responsible for scheduling the field activity. Each field activity event will be defined by the site requirements and the data requiring collection. The appropriate work plans will be referenced to specify the data that will be collected. After completing the schedule, the field team and data manager are informed of the requirements by holding a field planning meeting.
- **Mobilization** - Mobilizing for a field activity includes generating any specific field forms or checklists, ordering, receiving and inspecting required field equipment, and conducting required project-specific training.
- **Field Data Forms** - Field data forms that will contain predefined information about the field event (e.g., location identifiers, site name, and quality control samples) shall be preprinted to ensure consistency and increase efficiency in the field. Some projects may have automated field data collection systems that would replace the need for field forms (e.g., data loggers). These data loggers will be prepared and tested at this time.
- **Field Instruments** - Many instruments used for collecting field measurements require calibration. Calibration of these instruments provides for accurate field measurements. Information that must be collected during the calibration of field equipment includes the type of instrument, instrument serial number or property number, time and date of calibration, instrument reading before and after calibration, and the calibration medium used. Calibrations of field equipment shall always be completed in accordance with the manufacturer's recommendations. For field equipment that only requires a calibration check, the vendor's date of calibration shall be recorded.
- **Field Data** - Field data are always collected at the same time as analytical samples. Examples of field data are:
 - Photographs
 - Water quality parameters
 - Checklists
 - Surveys
 - Time and date of sample collection
 - Weather conditions
- **Quality Assurance Review** - The project manager is responsible for ensuring that quality assurance reviews are completed. A quality assurance review of the field data collected will be completed. The field data (e.g., logbooks, field forms) review ensures that the data are recorded correctly and the activities are completed in compliance with the planning documents. The quality assurance review will determine if discrepancies between the planned events and actual events occurred.

- **Compilation of Field Data** - The field team leader is responsible for ensuring that the field data are compiled and submitted to the data manager. Compiling the field data will include copying the field forms, downloading data loggers, and verifying that the field data were recorded as required.

5.2.3 Field Data Processing

Processing field data provides the mechanism for making the data available to the data users. The project manager is responsible for completing this process. Field data will include logbook copies, field forms, checklists, and data logger data. Since project data collection will vary significantly from one project to the next, not every project will require the completion of the following steps. An important part of preparing the data management plan is defining this process specific to the project requirements.

- **Project Files** - The field data collected during the field activity and any changes or deviations implemented must be documented and placed into the project files.
- **Field Data** - The following steps only apply to a project where an electronic database is required. Hardcopy field data will be entered into the electronic database. The data entry will be reviewed for accuracy by an independent person to verify correctness. Electronic field data (e.g., from data loggers) will be processed by programs that are designed for use with the specific piece of equipment that logged the data.
- **Error Resolution** - Any errors identified during field data processing or on review of field documentation must be resolved. Resolution is accomplished through discussions with project personnel.
- **Updates** - Upon completion of field data processing, the project database and project files must be updated. The data manager then makes the data available to project personnel for use.

5.2.4 Field Sample Collection

Field sample collection includes all activities implemented to gather samples from a particular site. Field sampling activities are planned and scheduled. Before implementation, the required field data forms, field logbooks, etc. are prepared. Recorded information is intended to provide data and observations to enable the reconstruction of the field sampling activities. The following process steps can be implemented as required:

- **Schedule** - The project manager will prepare a schedule of sampling events. The schedule shall include the types and number of samples to be collected at each location.
- **Generation of Sampling Labels and Forms** - Each sample collected during the scheduled sampling event will receive a sample label and sample collection form. Information to be captured on the sample container labels includes the sample location, container type, preservative, and analysis. Field forms for each can also be generated. Field forms may be preprinted and include lines for documenting conditions under which the sample was collected (e.g., moisture content, depth, water quality parameters).
- **Notification of Analytical Laboratories** - The analytical laboratories need to be notified of the sampling activity schedule. The laboratory needs to be informed of the anticipated arrival of sample shipments including the numbers of samples and the types of analyses that will be requested.
- **Acquisition of Equipment and Supplies** - All equipment required to complete the field sampling activity must be ordered, received, and documented. Notation of all equipment identification numbers and serial numbers must be made. An equipment checklist may be used to document this step. All supplies needed to accomplish the scheduled sampling activities, including sample containers and shipping materials need to be assembled.
- **Sample Collection** - Samples will be collected in accordance with required sampling procedures. Information regarding sampling activities, site conditions, and deviations from the planning documents will be recorded in the field logbook or field data forms.

- **Sample Processing** - Samples collected in the field may need additional preparation before shipping to the laboratory. Two examples of additional processing that may be required are compositing of samples and filtering of an aliquot of the sample.
- **Updates** - The project database and project files need to be updated with the information collected during the field activities. A part of this process includes the verification that field data entered into the database are correct. Verification consists of comparing field forms and field logbooks to the information entered.

5.2.5 Submitting Samples for Analysis

Submitting samples to a laboratory for analysis includes preparation, packing, documenting, shipping, and verification of sample receipt. The process for submitting samples to a laboratory for analysis is detailed below.

- **Preparation for Shipment** - Preparing to ship samples includes the final sample processing such as splitting, compositing, or filtering. All sample containers shipped to a laboratory must have labels identifying, at a minimum, the sample number or identifier, analyses to be completed, and sample collection date and time. Sampling shipments shall be completed in accordance with CDM Federal SOP 2-1, *Packaging and Shipping of Environmental Samples*.
- **Chain-of-Custody Documentation** - All samples collected need to be documented and accompanied by a chain-of-custody form. The chain-of-custody must identify, at a minimum, the following:
 - Sample identification number
 - Matrix
 - Collection date and time
 - Sample type
 - Preservative
 - Analyses
 - Signature blocks for documenting sample transfers

Sample chain-of-custody must be completed in accordance with CDM Federal SOP 1-2, *Sample Custody*.

- **Shipping Samples** - Samples will be shipped in accordance with CDM Federal SOP 2-1, *Packaging and Shipping of Environmental Samples*. Each sample shipped shall be checked against the chain-of-custody as it is packed for shipment.
- **Laboratory Receipt of Samples** - The laboratory will confirm that custody seals are still intact, the number of samples received matches the chain-of-custody, and the analyses match the sample labels and chain-of-custody. Additionally, the laboratory will note the condition of the samples when they are received against any noted requirements (e.g., 4° Celsius) on the chain-of-custody. The chain-of-custody will be signed and dated as received by the laboratory. A copy of the chain-of-custody shall be faxed back to the shipper for confirmation of sample receipt.
- **Confirmation of Sample Receipt** - The laboratory coordinator is responsible for confirming that the information provided by the laboratory is accurate. Confirmation is required for the following items:
 - What samples were received
 - Condition of samples upon receipt
 - Presence of signature on laboratory chain-of-custody form
 - Sample identification numbers
 - Types of analyses performed

The laboratory coordinator is responsible for resolution and reconciliation of any conflicting information.

- **Sample Shipping Documentation** - Sample shipment files will include information with respect to the completion of the shipping process. This documentation will include:
 - Signed copy of the chain-of-custody
 - Shipping company airbill if applicable
 - Laboratory sample receipt or login form
 - Field forms associated with samples included in the shipment
- **Laboratory Analysis** - The laboratory will analyze samples according to the laboratory statement of work and the requested analyses identified on the chain-of-custody.

5.2.6 Sample Data Processing

Sample data processing includes receiving and processing the laboratory data package and making the data available for review. Activities associated with this process are data package receipt, evaluation of the data package, and updating the project database with the data package information. The process for these activities is detailed below.

- **Receiving the Data Package** - The laboratory shall send the data package to the project laboratory coordinator. At a minimum, the data package will consist of a hardcopy of the analytical results. The laboratory coordinator will note which samples the data package represents and review the data package for completeness and legibility. Any problems identified during this review must be communicated to the laboratory and corrected. If an electronic data deliverable is a part of the data package, it may be either sent directly to the data management team or retained by the laboratory coordinator and distributed after review. If an electronic data deliverable is not provided as a component of the data package and the data needs to be entered into the database, the laboratory coordinator will provide a copy of the data package to the data management team as required for data entry.
- **Evaluation of the Data Package** - Upon receipt of electronic data deliverables, the CD-ROM or other media will be scanned for possible viruses before loading the information onto a computer. If a virus is detected, the laboratory will be notified immediately and another electronic deliverable requested. Electronic data deliverables shall be compared to the hardcopy version of the data package to ensure consistency and accuracy. In cases where no electronic copy exists, and the entry of the hardcopy data package into an electronic database is a project requirement, verification of the accuracy of the entered data is required subsequent to completion of data entry. All errors and problems identified during the evaluation must be documented and resolved during the evaluation. Any changes made to the hardcopy data package and the electronic data package must be documented.
- **Update the Project Database** - The project database will be updated with the sample results and associated laboratory data qualifiers. Some projects may also require additional quality control information in the database. Examples of the type of information that may be required include:
 - Results from the matrix spike/matrix spike duplicates
 - Laboratory control samples
 - Percent recoveries
 - Blanks

Documentation of problem resolution and changes made to the data package must be maintained.

5.3 Review and Data Use

The data review process determines whether a set of environmental data meets the requirements established during the project scoping. The process involves the data management team, the laboratory coordinator, and the data users. Before completing the data review, the data validation and evaluation process must be completed to ensure data meet analytical guidelines since qualifiers affect the usability of the data..

5.3.1 Data Validation and Evaluation

Validation and evaluation of environmental data is performed to evaluate the usability of the data for the intended application. The process is equally applicable to field data as well as analytical laboratory data. Data of questionable quality or representativeness are qualified to inform the data user of the limitations associated with the data use. The process to complete a data validation and evaluation is presented below.

- **Data Deliverables** - Data are received in either hardcopy or electronic format by the data validation coordinator. These data deliverables are evaluated against the requirements specified in the analytical laboratory statement of work or the client requirements. Upon completion of the evaluation of the data deliverables with respect to the contract requirements (laboratory subcontract or client contract), the data deliverables are forwarded to the validation and evaluation personnel. If the data validation and evaluation is not required for the data deliverable, it is forwarded to the data manager for uploading into the project database.
- **Validation and Evaluation of Data** - Data deliverables are validated and evaluated according to the procedures and requirements established during the project planning and data management plan development. Following validation and evaluation, the data are forwarded to the data management team for subsequent update of the project database.

- **Data Validation and Evaluation Report** - The data validator and evaluator will prepare a report documenting the process used to validate and evaluate the data, the usability of the data, and the qualification of the data, if applicable.

5.3.2 Data Review

Review of the data encompasses all data and supporting documentation, historical and recent, collected by the project activities as defined during the project scoping. Evaluation of the data will include the following process.

- **Evaluate Data for Outliers** - The data evaluation will first review the data to detect possible outliers. If extreme values are observed, a review of the potential for sampling and analysis problems must be completed to determine the accuracy of the data point. This review may include the evaluation of historical data ranges for the particular analyte at a particular location, or comparing similar analytical method results for samples processed differently (e.g., filtered vs. unfiltered). Based on the results of this evaluation, a determination about the use of the outlier result can be made.
- **Evaluate Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC)** - Precision, accuracy, representativeness, completeness, and comparability make up the PARCC parameters.

Precision is the degree of agreement between independent measurements and is determined by the evaluation of laboratory control sample and laboratory control sample duplicate pairs, the matrix spike/matrix spike duplicate pair or an environmental sample and environmental duplicate pair analyses.

Accuracy is the closeness of agreement between an observed value and an accepted value. Accuracy is determined by comparing percent recovery of spiked samples such as laboratory control samples and matrix spike samples.

Representativeness expresses the degree to which the data accurately reflect the analyte or parameter for the environmental media examined at the site. Representativeness is a qualitative term and is evaluated based on use of proper sample design, sample collection methods, use of standard analysis methods, etc.

Completeness is the measure of the amount of valid data received from the laboratory or field measurements. Completeness is determined by dividing the number of valid results by the number of possible results.

Comparability is the confidence with which one data set may be compared to another data set produced by different laboratories or field instruments. Comparability is a qualitative term and can be evaluated by reviewing sampling methods, sampling devices, and standard control limits. Understanding the PARCC parameters provides a level of confidence in the data reported for decisionmaking purposes.

- **Evaluate Data Quality** - An integral component of the data review process is the comparison of results against the project-specific data quality requirements established during project planning. Results of the data quality evaluation will determine if the data meet or exceed the data quality requirements necessary for decisionmaking. A final usability determination is made by the data reviewers. If required, data qualifiers are placed on the data to indicate usability.
- **Update Database** - After the data review is complete, the project database must be updated with the qualifiers assigned. Updating of the database also includes noting the qualifiers on the hardcopy of the data package.

5.3.3 Data Analysis and Use

Data analysis and use consists of the activities necessary to process the data and transform the entire data set into customized data sets for the generation of deliverables for decisionmaking and reporting. Data users may use only portions of data (e.g., geological or chemical) or summarize the data to generate tables, graphs, text, maps, or other deliverables necessary to describe the results obtained and the conclusions drawn. The analysis process is very often iterative. Results and conclusions from one analysis will often lead to other analyses. The process for data analysis and use is presented below.

- **Data Selection** - Data analysis will usually focus on a particular subset of the data collected. Data selection involves defining these subsets, querying the data, consolidating these data from the project database, and transferring the data to the appropriate tool for analysis (drafting, GIS, statistical program, etc.). Standardization may also need to occur at this point in the process (e.g., units, analytes, spatial).

- **Report and Analyze Data** - Data analysis involves summarizing the data to ensure that the technical requirements of the project are met. Examples of data analysis include statistical, risk assessment, and modeling. Results of the analysis are then used to report information in the form of tables, graphs, maps, text, and three-dimensional visualizations.
- **Documentation** - The information necessary to recreate a data analysis must be documented and kept. This includes the query criteria used to acquire the data subset, the database that provided the data for analysis, the procedure completed to perform the analysis, and the date the analysis is performed.

6.0 Software and Computer System

This section defines the documentation, quality assurance, and configuration control requirements for software and databases used on environmental projects. Section 6.1 applies to all projects using an electronic database and provides requirements for project-specific databases and software. Section 6.2 applies to all projects using an electronic database and defines requirements for the day-to-day operation of the data management system. The project data manager is responsible for implementation and providing guidance to meet the project objectives.

6.1 Project-Specific Database and Software Requirements

The need for a project-specific database and software will vary depending on the requirements of the project. A project may use an existing data management system and therefore not have project-specific software or databases, while other projects may develop project-specific databases and spreadsheets or software programs to analyze the project data. This section presents the minimum documentation, quality assurance, and configuration control requirements for project-specific databases and software developed during the course of a project.

- **Database Documentation** - Project databases will include spreadsheets and databases defined by the project data management team. The database documentation will identify the commercial database product, the database name, structure, and location using an entity relationship diagram (ERD) and data dictionary. The backup and recovery plans and processes for the database will also be documented. The minimum database documentation will consist of the name of the software used, names of the project databases created, database structure definitions (including names and field descriptions), any table relationships, and the storage location.
- **Software Documentation** - Software documentation will include the software program name, description, special requirements, revision, completion date, and evidence of technical and quality review. Documentation of deliverables created must also include the necessary information required to describe exactly how the data deliverable was produced. Software documentation may be maintained in hardcopy or included as a comment block embedded within the project software program. The minimum software documentation will consist of the name of the commercial software, name and version of any software written by the project personnel, author, date, revision, system requirements, and storage location.
- **Software Quality Assurance** - The project will define the quality assurance requirements for project-specific software. At a minimum, the functionality and analytical results of software programs will be reviewed to ensure that they meet requirements and objectives. The reviewer of the software will be someone other than the person who wrote the program. The project-specific software quality assurance requirements will be defined in the project data management plan.
- **Software Configuration Control** - Project-specific software will be protected from unauthorized modification or deletion. This can be accomplished by administrative controls or file security options. Changes to project software will be documented and maintained in the project files. The minimum project software configuration control documentation will include the commercial software used, the program names, revisions including the date, and the storage location.

6.2 System Administration

This section addresses the day-to-day operations of the data management system, including backups, access, security, data entry, and database control. All projects using an electronic database will adhere to the requirements in this section. The data manager is responsible for implementation of system security.

- **System Backup** - Project data will be protected from loss through a preventive backup and recovery process. Database backups will be performed on a periodic basis at a frequency to be defined for each project in the data management plan. The frequency will be selected to minimize the extent of consequences of data loss and time required to recover the data. Recovery procedures will be developed and documented. The detailed description of the backup and recovery procedures will be presented in the data management plan.
- **System Access** - Access to the computer system will be made available only to authorized personnel with an assigned role that specifies their access rights. Before gaining access, personnel may login by providing a login name and password.
- **Database Access** - Projects will protect data from unauthorized access by implementing administrative controls. Access will be managed based on the specific data user role. The mechanism for implementing control will be documented in the project data management plan.
- **Data Security** - Security considerations must establish a balance between making the data inaccessible to unauthorized individuals while still making it accessible to those who have access and maintaining the integrity of the data. Security processes apply to field data, electronic data, the database, and distribution of data outside of CDM. Original copies of all field records (e.g., chain-of-custody forms, sample collection sheets, and shipping airbills) will be placed in the permanent project file. All electronic files will be maintained in an electronic file management system and administered accordingly. Security of data distributed outside of CDM will be maintained by providing read only access to the data and/or including time, date, and version on the data files within the file naming convention.
- **Data Entry** - Data entry and transcription activities will be reviewed and checked to ensure that data integrity is maintained. Review and checking must occur for all data when moving or copying data from one media to another. For example, if a field technician collects data from a water quality instrument and records it in a logbook, enters the data from the logbook into an electronic format, and then transfers the data into a deliverable, verification of accuracy would be completed during or immediately after the transcription. The mechanism for data entry and transcription must be documented in the project data management plan.
- **Database Control** - Each project must establish database control requirements for the contents of the project database. The requirements must ensure traceability of field and laboratory data from its original reported values through changes to current values stored in the database. The control requirements will define the approval process required for making changes to the database and the documentation required for each database change. The minimum information maintained for each database change will include:
 - Description of the change
 - Name of the individual making the change
 - Reason the change was made
 - Date the change was made

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Environmental Data Management

SOP 4-8
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TSOP 5-1

CONTROL OF MEASUREMENT AND TEST EQUIPMENT

Control of Measurement and Test Equipment

SOP 5-1
Revision: 8
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Prepared: Dave Johnson

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Approved: 

Issued: 

Signature/Date

Signature/Date

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE). Contractual obligations may require more specific or stringent requirements that must also be implemented.

2.0 Background

2.1 Definitions

Traceability - The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Associated Procedures

- CDM Federal Technical SOP 4-1, *Field Logbook Content and Control*
- CDM Quality Procedures (QPs) 2.1 and 2.3
- Manufacturer's operating and maintenance and calibration procedures

2.3 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of this equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures and in accordance with any other related project-specific requirements.

3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE are responsible for being knowledgeable of and understanding and implementing the requirements contained herein as well as any other related project-specific requirements.

The project manager (PM) or designee (equipment coordinator, quality assurance coordinator, field team leader, etc.) is responsible for initiating and tracking the requirements contained herein.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Requirements for M&TE

- Determine and implement M&TE related project-specific requirements
- The maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an equipment log or a field log as appropriate (Figure 1)
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

5.0 Procedures

5.1 Determine if Other Related Project-Specific Requirements Apply

For all M&TE:

The PM or designee shall determine if M&TE related project-specific requirements apply. If M&TE related project-specific requirements apply, obtain a copy of them and review and implement as appropriate.

5.2 Obtain the Operating and Maintenance and Calibration Documents

For GF M&TE that is to be procured:

Requisitioner - Specify that the maintenance and calibration procedures be included.

For GF M&TE that is acquired as a result of a property transfer:

Receiver - Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, order the appropriate documentation from the manufacturer.

For M&TE that is to be rented or leased from an outside vendor:

Requisitioner - Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, ask the procurement division to request it from the vendor.

5.3 Prepare and Record Maintenance and Calibration Records

For all M&TE:

PM or Designee - Record all maintenance and calibration events in a field log unless other project-specific requirements apply.

For GF M&TE only (does not apply to rented or leased M&TE):

If an equipment log is a project specific requirement, perform the following:

Receiver - Notify the PM or designee for the overall property control of the equipment upon receipt of an item of M&TE.

PM or Designee and User:

- Prepare a sequentially page numbered equipment log for the item using the maintenance and calibration form (or equivalent) (Figure 1).
- Record all maintenance and calibration events in an equipment log.

5.4 Label M&TE Requiring Calibration

For GF M&TE only (does not apply to rented or leased M&TE):

If calibration labeling is a project specific requirement, perform the following:

PM or Designee:

- Read the maintenance and calibration procedures to determine the frequency of calibration required.
- If an M&TE item requires calibration before use, affix a label to the item stating "Calibrate Before Use."
- If an M&TE item requires calibration at other scheduled intervals, e.g., monthly, annually, etc., affix a label listing the date of the last calibration, the date the item is next due for a calibration, the initials of the person who performed the calibration, and a space for the initials of the person who shall perform the next calibration.

5.5 Operating, Maintaining or Calibrating an M&TE Item

For all M&TE:

PM or Designee and User - Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the equipment log or field log.

5.6 Shipment

For GF M&TE:

Shipper - Inspect the item to ensure that the maintenance and calibration procedures are attached to the shipping case, or included, and that a copy of the most recent equipment log entry page (if required) is included with the shipment. If the maintenance and calibration procedures and/or the current equipment log page (if required) is missing or incomplete, do not ship the item. Immediately contact the PM or designee and request a replacement.

Control of Measurement and Test Equipment

SOP 5-1
Revision: 8
Date: March 2007

For M&TE that is rented or leased from an outside vendor:

Shipper - Inspect the item to ensure that the maintenance and calibration procedures and latest calibration and standards certification records are included prior to shipment. If any documentation is missing or incomplete, do not ship the item. Immediately contact the procurement division and request that they obtain the documentation from the vendor.

5.7 Records Maintenance

For GF M&TE:

PM or Designee - Create a file upon the initial receipt of an item of M&TE or calibration standard. Organize the files by contract origin and by M&TE item and calibration standard. Store all files in a cabinet, file drawer, or other appropriate storage media at the pertinent warehouse or office location.

Receiver - Forward the original packing slip to the procurement division and a photocopy to the PM or designee.

PM or Designee and User:

- Maintain all original documents in the equipment file except for the packing slip and field log.
- File the photocopy of the packing slip in the M&TE file.
- Record all maintenance and calibration in an equipment log or field log (as appropriate). File the completed equipment logs in the M&TE records. Forward completed field logs to the PM for inclusion in the project files.

For M&TE rented or leased from an outside vendor:

Receiver - Forward the packing slip to the procurement division.

User:

- Forward the completed field log to the PM for inclusion in the project files.
- Retain the most current maintenance and calibration record and calibration standards certifications with the M&TE item and forward previous versions to the PM for inclusion in the project files.

5.8 Traceability of Calibration Standards

For all items of M&TE:

PM or Designee and User:

- When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.
- Require certifications for standards that clearly state the traceability.
- Require Material Safety Data Sheets to be provided with standards.
- Note standards that are perishable and consume or dispose of them on or before the expiration date.

5.9 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:

PM or Designee

- Immediately discontinue use and segregate the item from other equipment. Notify the appropriate PM and take appropriate action in accordance with the CDM QP 2.3 for nonconforming items.
- Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate PM(s) of the results of the review.

6.0 Restrictions/Limitations

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the Headquarters health and safety manager and/or Headquarters quality assurance director. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 References

CDM Federal Programs Corporation. 2007. *Quality Assurance Manual*. Rev. 11.

CDM Federal Programs Corporation. 2005. *Government Property Manual*. Rev. 3.

Control of Measurement and Test Equipment

SOP 5-1
Revision: 8
Date: March 2007

Figure 1



A subsidiary of Camp Dresser & McKee Inc.

Maintenance and Calibration

Date: _____ Time: (a.m./p.m.) _____

Employee Name: _____

Equipment Description: _____

Contract/Project: _____

Equipment ID No.: _____

Activity: _____

Equipment Serial No.: _____

Maintenance

Maintenance Performed: _____

Comments: _____

Signature: _____ Date: _____

Calibration/Field Check

Calibration Standard: _____

Concentration of Standard: _____

Lot No. of Calibration Standard: _____

Expiration Date of Calibration Standard: _____

Pre-Calibration Reading: _____

Post-Calibration Reading: _____

Additional Readings: _____

Additional Readings: _____

Additional Readings: _____

Additional Readings: _____

Pre-Field Check Reading: _____

Post-Field Check Reading: _____

Adjustment(s): _____

Calibration: ☐ Passed ☐ Failed

Comments: _____

Signature: _____ Date: _____

PSOP-1
DIFFUSION BAGS

PROJECT-SPECIFIC OPERATING PROCEDURE
Maunabo Contaminated Groundwater Site
Maunabo, Puerto Rico

SOP No.: 1
Revision: 0
Date: 4/18/2007

SOP Title: Passive Diffusion Bag Water Sampling

QA Review: [Signature]

Approved: [Signature]

Program Manager Signature/Date

RATIONALE

Passive diffusion bag (PDB) samplers will be used to evaluate groundwater seepage volatile organic compounds (VOC) concentrations in piezometers at the Maunabo Groundwater Site in Maunabo, Puerto Rico. These samplers consist of a semi-permeable bag filled with laboratory grade analyte-free water. The typical bag is approximately one to two feet long and 1.2 inches in diameter for two-inch diameter piezometer (Vroblesky 2001a). The diffusion sampler is lowered into the piezometer and the analyte-free water allowed to equilibrate with VOCs in the groundwater. Equilibration time varies depending on the VOC-specific chemical/physical characteristics and ambient groundwater conditions, but a range of VOCs have been shown to reach equilibrium concentrations within 2 weeks of deployment (Interstate Technology and Regulatory Council (ITRC) Diffusion Sampler Workgroup 2002). The samplers will be installed for approximately 2 weeks prior to collection. This data will be used to determine if VOCs are present in groundwater seepage.

The use of water-filled PDB samplers is based upon the diffusion of VOCs in the groundwater across the bag material. VOCs in groundwater will tend to diffuse across the bag material until constituent concentrations in the bag and the surrounding groundwater reach equilibrium. The water in the PDB sampler is then analyzed by a laboratory. PDB samplers have been recommended for use in long term groundwater monitoring in wells (ITRC 2002).

Published data have generally shown that concentrations obtained by PDB samplers deployed in monitoring wells are close to concentrations found in groundwater samples collected from the wells (Vroblesky et al, 1999 and Vroblesky 2001b). The research indicates PDB samplers generally function as designed: once equilibrium is reached, the PDB data generally compares closely with more traditional groundwater data. According to USGS Fact Sheet 088-01, Harte et al (in press) found that although VOC concentrations changed during the deployment periods, the PDB concentrations were similar to those of samples purged at the time of retrieval.

PREPARATORY ACTIVITIES

Prior to the field activities, the necessary field equipment listed below will be checked in order to ensure that all are in proper working condition. The manufacturers' operating manuals will be reviewed to confirm that the proper equipment operation procedures are used in the field. The field team will review and discuss, in detail, the Health and Safety Plan (HSP) and any appropriate Quality Assurance Project Plan (QAPP) sections. All monitoring and protective equipment will be thoroughly checked prior to field activities.

FIELD EQUIPMENT

The principal equipment used for the collection of groundwater samples by diffusion sampling will be constructed of material compatible with sampling for trace concentrations of VOCs. The required equipment is summarized below.

- | | |
|----------------------------------|------------------------------------|
| • Passive diffusion bag samplers | • Chain of custody |
| • Weighted line | • Electronic water level indicator |
| • Pointed discharge tube | • Blank log sheets |
| • Razor blade | • Measuring tape |
| • Latex or nitrile gloves | • Camera and film |
| • Field logbook | • Field table |
| | • Polyethylene sheeting |

PROJECT-SPECIFIC OPERATING PROCEDURE

SOP No.: 1
Revision: 0
Date: 4/18/2007

SOP Title: Passive Diffusion Bag Water Sampling

- | | |
|---|---|
| • Utility knife | • Sample containers |
| • Duct tape | • Sample paperwork and sample labels |
| • Deionized water | • Nylon-fiber strapping tape |
| • Laboratory grade analyte-free water | • Clear tape |
| • Decontamination equipment | • Plastic baggies |
| • Personnel protective equipment | • Paper towels |
| • Air monitoring equipment and calibration span gas | • Coolers |
| | • Ice |
| | • Vermiculite (except if shipping to DESA Laboratory) |

FIELD PROCEDURES

Passive Diffusion Bag Sampling for Groundwater Seepage VOC Concentrations

1. Don new, uncontaminated latex or nitrile gloves.
2. Commercially available PDB samplers equipped with protective webbing will be utilized during this project. The PDB samplers will be filled with laboratory grade analyte-free water prior to deployment (certification sheets are required for the water). As an option, pre-filled PDBs are available from some manufacturers.
3. The PDB sampler will hang on a line lowered down the piezometer (See figure below). The line shall be stainless steel wireline cable. A hanger will be installed at the top of the line. A stainless steel weight of 20 ounces and 1.5 inches in diameter will be secured to the bottom of the line so the line will hang straight. The weight will be supplied by the PDB vendor.



PROJECT-SPECIFIC OPERATING PROCEDURE

SOP No.: 1
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SOP Title: Passive Diffusion Bag Water Sampling

4. When installing the PDB sampler in the piezometer obtain a single weighted line of a suitable length to reach from the tie-off point at the top of the well to a point below the intended location of the bottom PDB sampler. The weight may rest on the bottom of the well if the weighted line is kept taut.
5. The PDB sampler will be secured to the bottom of the weighted line using clips, cable ties, or other devices. Care should be taken that the method for connection doesn't allow the sampler to slip from their intended location. The sampling depth will be provided based on the depth of the piezometer screen interval. The piezometer screen interval at the Maunabo site is anticipated to be 12 inches long and set approximately three to four feet into the streambed.
6. Each PDB sampler should be secured to the weighted line at the top and at the bottom of the sampler to prevent the sampler from becoming dislodged during installation and retrieval.
7. After approximately two weeks, remove the PDB sampler from the well and disconnect the suspension cord from the top handle of the sampler.
8. Remove the hanger and weight.
9. Locate the small diameter, pointed discharge tube that is supplied with commercially available PDB samplers. The pointed discharge tube is similar to a juice box pointed straw. Figure of the PDB, discharge tube and sample vial is displayed below (EON Products, Inc.)
10. Select a point near the bottom of the PDB sampler and above the PDB fill nozzle and press one end of the discharge tube firmly into the clear polyethylene membrane until it pierces the membrane. Flow will begin immediately.
11. Manipulate the PDB sampler to start and stop flow as needed.



12. Place the other end of the discharge tube into the sample vial and gently position the sampler for effective discharge. Follow the procedure below: *"Sample Container Filling Procedures for VOC Groundwater Seepage Samples"*.
13. Place the sample containers in the iced cooler.
14. Complete all required documentation, including field logbook entries, sample container label, and chain-of-custody form.

PROJECT-SPECIFIC OPERATING PROCEDURE

SOP Title: Passive Diffusion Bag Water Sampling

SOP No.: 1
Revision: 0
Date: 4/18/2007

Sample Container Filling Procedures for VOC Groundwater Seepage Samples

1. Don clean sample-dedicated surgical, phthalate-free gloves.
2. Remove the cap from the 40-mL VOA sample vial, avoiding contact with cap liner.
3. The first VOA vial will be used to determine the minimum amount of HCl required to bring the sample pH to < 2. Fill the vial with sample water, then add 1:1 HCl drop by drop into the VOA vial and test pH until it is less than 2. Record the amount of HCl added and set aside this VOA vial for disposal.
4. Add the established amount of HCl to the remaining VOA vials. Gently transfer sample to the VOA vial. Collect the groundwater from the sampler by tilting while filling to prevent aeration and quickly replace the cap. Check to make sure the cap is sealed on tightly. Inspect the vial for air bubbles to check that zero head space has been achieved. Discard any vials with bubbles.
5. Clean the outside of the sample containers with clean water and paper towels. Log the physical description of the sample, its depth interval, and its corresponding CDM Federal sample identification number in the field logbook.
6. Complete paperwork, pack and ship samples as described in CDM Federal TSOP 1-2 "Sample Custody" and TSOP 2-5 "Packaging and Shipping of Environmental Samples".
7. Record all appropriate data in the appropriate field logbook in accordance with TSOP 4-1, "Field Logbook Content and Control".
8. Duplicate, field blank, and trip blank samples will be prepared according to the project QAPP.

REFERENCES

ITRC Diffusion Sampler Workgroup, November 6, 2002, Recommendations for the Use of Polyethylene Diffusion Bag Samplers for the Long-Term Monitoring of Organic Compounds in Groundwater

United States Geological Survey. Fact Sheet 088-01: Use of Passive Diffusion Samplers for Monitoring Volatile Organic Compounds in Ground Water.

Vroblecky, Don A., 2001a, User's Guide For Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells - Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance. United States Geological Survey, Water-Resources Investigations Report 01-4060.

_____. 2001b. User's Guide For Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells - Part 2: Field Tests. United States Geological Survey, Water-Resources Investigations Report 01-4061.

Vroblecky, Don A., Nietch, Christopher T., Robertson, John F., Bradley, Paul M., Coates, John, and Morris, James T. 1999. Natural Attenuation Potential of Chlorinated Volatile Organic Compounds in Ground Water. TNX Flood Plain. Savannah River Site. South Carolina. United States Geological Survey. Water-Resources Investigations Report 99-4071.

CDM Federal Programs Corporation TECHNICAL/QA REVIEW FORM

QC Check ☐ Technical Review ☒ QA Review ☒

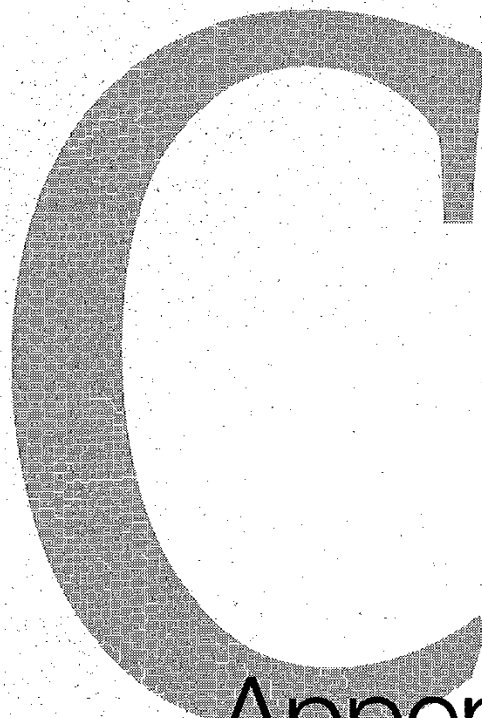
Check reviews required above

Document Type: <u>Project Standard Operating Procedure</u>		Author: <u>Mike Valentino</u>	
Title: <u>Passive Diffusion Bag Project Standard Operating Procedure</u>			
DCN: <u>XXXX</u>	Revision Number: <u>0</u>	Date: <u>4/18/07</u>	
Contract/Project: <u>RAC II/171</u>			
100% QC Check on Tables, Figures, and Text Compared to Actual Laboratory Data Conducted by:			
Signature: _____		Date: _____	
Instructions to Technical/QA Reviewers:			
Charge No: <u>3223.171.PPZ.QAPPZ</u>		Project Manager: <u>Mike Valentino</u>	
Estimated Review Hours*: Technical: <u>1</u>		QA: <u>1</u>	
Date Sent: <u>4/18/07</u>		Due Date for Comments: <u>4/19/07</u>	
Return Comments to: <u>Mike Valentino</u>			
Background and Instructions:			
Technical Reviewer:		QA Reviewer:	
Name: <u>Joe Mayo</u>		Name: <u>Jennifer Oxford</u>	
Location: <u>NYC</u>		Location: <u>NYC</u>	
Technical Reviewer Signature: <u><i>Joe Mayo</i></u>		Date: <u>4/18/07</u>	
<input checked="" type="checkbox"/> Spot-check accuracy of equations, calculations, reference citations, tables, and figures			
QA Reviewer Signature: <u><i>J Oxford</i></u>		Date: <u>4/18/07</u>	
<input checked="" type="checkbox"/> Check consistency between tables, figures, and text			
Return for Follow-up Technical review? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Return for Follow-up QA review? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
Concurrence with Comment Resolution – Required When Follow-up Review is Required			
Reviewer's Signature: <u><i>J Oxford</i></u>		Date: <u>4/19/07</u>	
Reviewer's Signature: _____		Date: _____	
Review Comments Incorporated/Resolved – Required for all Reviews			
Project Manager's Signature: _____		Date: _____	

*If Reviewer requires more time, discuss with Project Manager.

Technv 3/2006

R2-0000641

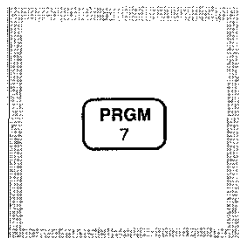


Appendix C

APPENDIX C
FERROUS IRON HACH METHOD

IRON, FERROUS (0 to 3.00 mg/L)

For water, wastewater, and seawater

1,10 Phenanthroline Method* (Powder Pillows or AccuVac Ampuls)**Using Powder Pillows**

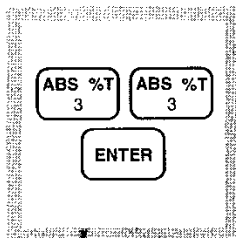
1. Enter the stored program number for Ferrous iron (Fe^{2+})-powder pillows.

Press: **PRGM**

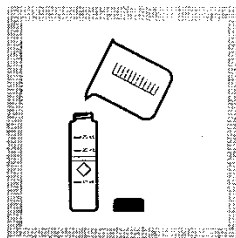
The display will show:

PRGM ?

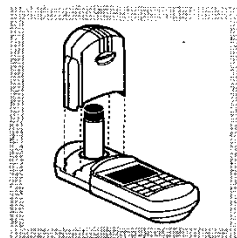
Note: Analyze samples as soon as possible to prevent oxidation of ferrous iron to ferric iron, which is not determined.



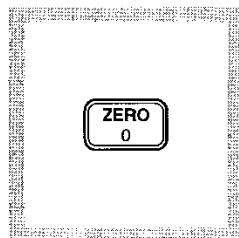
2. Press: **33 ENTER**
The display will show **mg/L, Fe** and the **ZERO** icon.



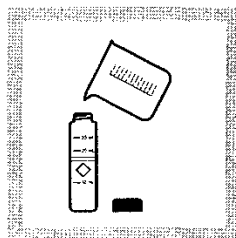
3. Fill a sample cell with 25 mL of sample (the blank).



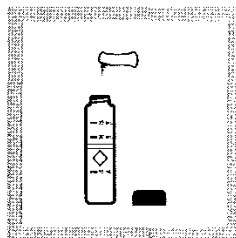
4. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



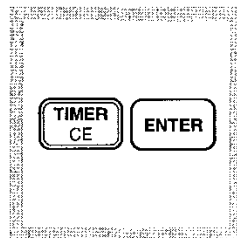
5. Press: **ZERO**
The cursor will move to the right, then the display will show:
0.00 mg/L Fe



6. Fill another sample cell with 25 mL of sample.



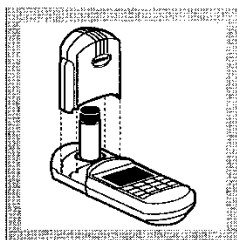
7. Add the contents of one Ferrous Iron Reagent Powder Pillow to the sample cell (the prepared sample). Cap and invert to mix.
Note: Undissolved powder does not affect accuracy.



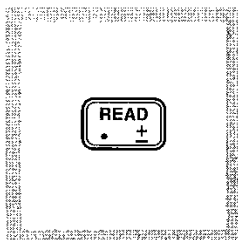
8. Press: **TIMER ENTER**
A three-minute reaction period will begin.
Note: An orange color will form if ferrous iron is present.

* Adapted from *Standard Methods for the Examination of Water and Wastewater*.

IRON, FERROUS, continued



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

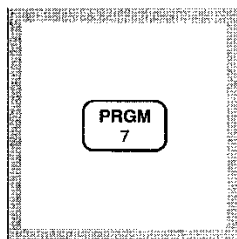


10. Press: **READ**

The cursor will move to the right, then the result in mg/L ferrous iron will be displayed.

Note: Standard Adjust may be performed using a prepared standard (see Section 1).

Using AccuVac Ampuls



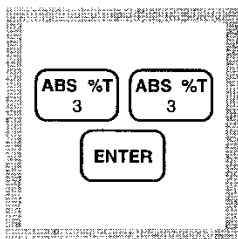
1. Enter the stored program number for ferrous iron (Fe^{2+}) AccuVac ampuls.

Press: **PRGM**

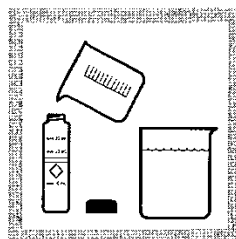
The display will show:

PRGM ?

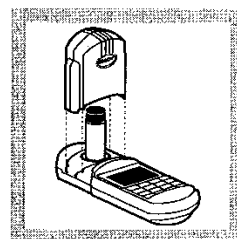
Note: Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric, which is not determined.



2. Press: **33 ENTER**
The display will show **mg/L, Fe** and the **ZERO** icon.

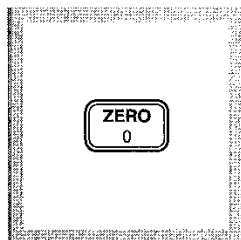


3. Fill a sample cell with at least 10 mL of sample (the blank). Collect at least 40 mL of sample in a 50-mL beaker.



4. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

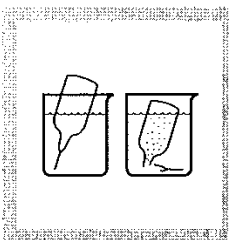
IRON, FERROUS, continued



5. Press: ZERO

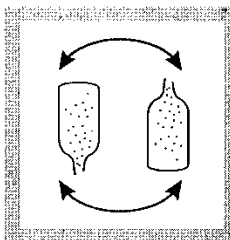
The cursor will move to the right, then the display will show:

0.00 mg/L Fe



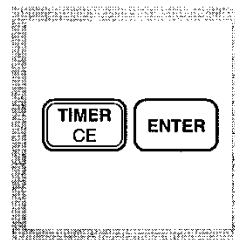
6. Fill a Ferrous Iron AccuVac Ampul with sample.

Note: Keep the tip immersed while the ampul fills completely.



7. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

Note: Undissolved powder does not affect accuracy.

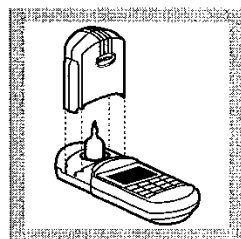


8. Press:

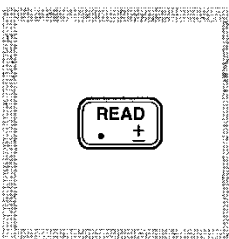
TIMER ENTER

A three-minute reaction period will begin.

Note: An orange color will form if ferrous iron is present.



9. Place the AccuVac ampul into the cell holder. Tightly cover the sample cell with the instrument cap.



10. Press: READ

The cursor will move to the right, then the result in mg/L ferrous iron will be displayed.

Note: Standard Adjust may be performed using a prepared standard (see Standard Adjust in Section 1).

IRON, FERROUS, continued

Sampling and Storage

Ferrous iron must be analyzed immediately and cannot be stored. Analyze samples as soon as possible to prevent oxidation of ferrous iron to ferric iron, which is not measured.

Accuracy Check

Standard Solution Method

Prepare a ferrous iron stock solution (100 mg/L Fe^{2+}) by dissolving 0.7022 grams of ferrous ammonium sulfate, hexahydrate, in deionized water. Dilute to 1 liter. Prepare immediately before use. Dilute 1.00 mL of this solution to 100 mL with deionized water to make a 1.00 mg/L standard solution. Prepare immediately before use.

Run the test using the 1.00 mg/L Fe^{2+} Standard Solution by following either the powder pillow or AccuVac procedure. Results should be between 0.90 mg/L and 1.10 mg/L Fe^{2+} .

Method Performance

Precision

In a single laboratory using an iron standard solution of 2.00 mg/L Fe^{2+} and two representative lots of powder pillow reagents with the instrument, a single operator obtained a standard deviation of ± 0.017 mg/L Fe^{2+} .

In a single laboratory using a standard solution of 2.00 mg/L Fe^{2+} and two representative lots of AccuVac ampuls with the instrument, a single operator obtained a standard deviation of ± 0.009 mg/L Fe^{2+} .

Estimated Detection Limit

The estimated detection limit for program 33 (powder pillows and AccuVac Ampuls) is 0.03 mg/L Fe. For more information on the estimated detection limit, see *Section 1*.

Summary of Method

The 1,10-phenanthroline indicator in Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not react. The ferric iron (Fe^{3+}) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test.

IRON, FERROUS, continued

REQUIRED REAGENTS & APPARATUS (USING POWDER PILLOWS)

Description	Quantity Required		Cat. No.
	Per Test	Units	
Ferrous Iron Reagent Powder Pillows.....	1 pillow.....	100/pkg.....	1037-69
Sample Cell, 10-20-25 mL, w/ cap	2	6/pkg.....	24019-06

REQUIRED REAGENTS & APPARATUS (USING ACCUVAC AMPULS)

Ferrous Iron Reagent AccuVac Ampuls.....	1 ampul.....	25/pkg.....	25140-25
Beaker, 50 mL	1	each	500-41H

OPTIONAL REAGENTS

Ferrous Ammonium Sulfate, hexahydrate, ACS	113 g	11256-14
Water, deionized.....	4 L	272-56

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Balance, analytical, 115 V, 0.1 mg	each	28014-01
Balance, analytical, 230 V, 0.1 mg	each	28014-02
Clippers, for opening powder pillows	each	968-00
Flask, volumetric, 100 mL, Class A	each	14574-42
Flask, volumetric, 1000 mL, Class A	each	14574-53
Pipet, volumetric, Class A, 1.00 mL	each	14515-35
Pipet Filler, safety bulb.....	each	14651-00
Weighing Boat, 67/46 mm, 8.9 cm square	500/pkg.....	21790-00

For Technical Assistance, Price and Ordering

In the U.S.A.—Call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.



Appendix D

APPENDIX D

CDM DV SOP 029A, REVISION 0

STANDARD OPERATING PROCEDURE

CDM Federal Programs Corporation
USEPA Methods for General Chemistry

Date: July, 2001
SOP CDM-029A, Rev.0

PACKAGE COMPLETENESS AND DELIVERABLES

CASE NUMBER: _____ LAB: _____

SITE: _____

1.0 Data Completeness and Deliverables Yes No N/A

1.1 Has all data been submitted in a CLP or CLP-like deliverable format? ☐ ____ ____

1.2 Have any missing deliverables been received and added to the data package? ☐ ____ ____

ACTION: Call lab for explanation/resubmittal of any missing deliverables. If lab cannot provide them, note the effect on review of the data in the reviewer narrative.

2.0 Cover Letter, SDG Narrative

2.1 Is a laboratory narrative or cover letter present? ☐ ____ ____

2.0 Are the case number and/or SDG number contained in the narrative or cover letter? ☐ ____ ____

3.0 Data Validation Checklist

3.1 Does this data package contain:

Water data? ☐ ____ ____

Waste data? ☐ ____ ____

Soil/Solid data? ☐ ____ ____

GENERAL CHEMISTRY ANALYSES

1. Traffic Reports and Laboratory Narrative Yes No N/A

1.1 Are traffic report and/or chain-of-custody forms present for all samples? ☐ ____ ____

ACTION: If no, contact lab for replacement of missing or illegible copies. Qualify samples that are not traceable through signature records on COC's "R."

1.2 Do the traffic reports and/or chain-of-custody forms or SDG narrative indicate any problems with sample receipt, condition of the samples, analytical problems or special circumstances affecting the quality of the data? ☐ ____ ____

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ACTION: If samples were not iced or if the ice was melted upon arrival at the laboratory and the temperature of the cooler was elevated (> 10 degrees Celcius), flag all positive results "J" and all nondetects "UJ."

2.0 Holding Times and Preservation

2.1 Have any general chemistry parameters holding times, determined from the date of collection to date of extraction, been exceeded? ☐

2.2 Were all general chemistry parameters preserved properly? ☐

ACTION: The following table indicates holding time and preservation requirements for some common wet chemistry parameters for water samples. If technical holding times are exceeded, flag all positive results as estimated "J," and sample quantitation limits (nondetects) as "UJ." Document in the narrative that holding times were exceeded. If analyses were performed beyond **twice** the holding time, either on the first analysis or upon reanalysis, the reviewer must use professional judgement to determine the reliability of the data and the effects of additional storage on the sample results. At a minimum, all the data should at least be qualified "J," but the reviewer may determine that non-detects are unusable "R."

Table 1.1 Wet Chemistry Parameters Holding Times, Containers, and Preservatives			
Parameters	Containers	Preservatives	Holding Times
Specific Conductance	Plastic (P) or glass (G)	$4 \pm 2^{\circ}\text{C}$	28 days
Hardness	P, G	HNO_3 to $\text{pH} < 2$	6 months
Residue			
Filterable	P, G	$4 \pm 2^{\circ}\text{C}$	7 days
Nonfilterable	P, G	$4 \pm 2^{\circ}\text{C}$	7 days
Total	P, G	$4 \pm 2^{\circ}\text{C}$	7 days
Volatile	P, G	$4 \pm 2^{\circ}\text{C}$	7 days
Settleable Matter	P, G	$4 \pm 2^{\circ}\text{C}$	48 hours
Turbidity	P, G	$4 \pm 2^{\circ}\text{C}$	48 hours
Hexavalent chromium	P, G	$4 \pm 2^{\circ}\text{C}$	24 hours
Acidity and/or Alkalinity	P, G	$4 \pm 2^{\circ}\text{C}$	14 days
Ammonia	P, G	$4 \pm 2^{\circ}\text{C}$, H_2SO_4 to $\text{pH} < 2$	28 days
Bromide	P, G	None required	28 days
			30 days to soil extraction
Chromium, hexavalent	P, G	$4 \pm 2^{\circ}\text{C}$	24 hours-aqueous

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Table 1.1 Wet Chemistry Parameters Holding Times, Containers, and Preservatives

Parameters	Containers	Preservatives	Holding Times
Chloride	P, G	4 ± 2°C	28 days
Chlorine	P, G	None required	Analyze immediately
Cyanides	P, G	4 ± 2°C NaOH to pH>12 0.6 g ascorbic acid*	14 days
Ferrous Ion (Iron II)	P, G	4 ± 2°C	Analyze immediately
Fluoride	P, G	None required	28 days
Iodide	P, G	4 ± 2°C	24 hours
Nitrogen			
Ammonia	P, G	4 ± 2°C, H ₂ SO ₄ to pH<2	28 days
Kjeldahl, total	P, G	4 ± 2°C, H ₂ SO ₄ to pH<2	28 days
Nitrate plus Nitrite	P, G	4 ± 2°C, H ₂ SO ₄ to pH<2	28 days
Nitrate	P, G	4 ± 2°C	48 hours
Nitrite	P, G	4 ± 2°C	48 hours
Phosphorus			
Orthophosphate, dissolved	P, G	Filter on site; 4 ± 2°C 4 ± 2°C, H ₂ SO ₄ to pH<2	48 hours
Hydrolyzable	P, G	4 ± 2°C, H ₂ SO ₄ to pH<2	28 days
Total	P, G	4 ± 2°C, H ₂ SO ₄ to pH<2; Filter on site	28 days
Total, dissolved	P, G		24 hours
Silica	P, G	4 ± 2°C	28 days
Sulfate	P, G	4 ± 2°C	28 days
Sulfide	P, G	4 ± 2°C, add 2 mL zinc acetate plus NaOH to pH>9	7 days
Sulfite	P, G	None required	Analyze immediately
Biochemical Oxygen Demand	P, G	4 ± 2°C	48 hours
Chemical Oxygen Demand	P, G	4 ± 2°C, H ₂ SO ₄ to pH<2	28 days
Oil & Grease	G only	4 ± 2°C, H ₂ SO ₄ to pH<2	28 days
Organic Carbon	P, G	4 ± 2°C, H ₂ SO ₄ or HCl to pH<2	28 days
Phenolics	G only	4 ± 2°C, H ₂ SO ₄ to pH<2	28 days

* Only used in the presence of residual chlorine.

See the Lloyd Kahn method for requirements for soil total organic carbon (TOC)

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3.0 Calibration and Performance

Yes No N/A

NOTE: Specific deliverables will depend on the method and instrumentation used for analysis. Some of these deliverables may not be applicable to all general chemistry methods: initial and continuing calibration results, sample preparation log, and analytical run log.

3.1 Was the instrument calibrated at the appropriate frequency?

☐

NOTE: Initial calibration must be performed before any samples are analyzed. Continuing calibration samples should be analyzed at a 10% frequency. If not document this occurrence in the validation narrative. If no calibration was performed, "R" all sample results.

3.2 Were the minimum number of standards used in calibrating the instrument?

☐

NOTE: At a minimum, a three- to five-point curve bracketing sample concentration, plus a blank, must be generated daily for most wet chemical methods. The correlation coefficient for a linear standard curve must be ≥ 0.995 . For gravimetric methods, evidence of balance calibration must be provided. For titrimetric methods, documentation of titrant standardization must be provided. If a pH meter is used for the analysis, the meter must be calibrated with at least two pH buffer solutions.

3.3 Were the correlation coefficients ≥ 0.995 ?

Yes No N/A

☐

ACTION: If the calibration correlation coefficient for the standard curve is < 0.995 , qualify results greater than the reporting limit as estimated "J," and results less than the reporting limit as estimated "UJ."

3.4 Were appropriate standard concentrations used?

☐

3.5 Were continuing calibration recoveries within control limits?

☐

NOTE: For continuing calibration, the percent recovery for the calibration verification analysis should be within limits established by the laboratory or as specified in the analytical method. In the absence of such limits, it is recommended that limit of 90-110%R is used.

ACTION: If the %R for the continuing calibration is outside laboratory-generated or method-specific limits, the following action is to be taken:

- If the %R is greater than the upper control limit, qualify all associated detected results as estimated "J." Nondetected results do not require qualification.
- If the %R is less than the lower control limit, qualify all associated results as estimated, "J " or "UJ."

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In the absence of laboratory-generated or method-specified criteria, control limits of 90-110%R shall be used, and the following action taken in addition to the what is stated above:

- If the %R is >125%, qualify positive results as unusable "R"; nondetected results are acceptable.
- if the %R is <75%, qualify all results (detects and nondetects) as unusable, "R."

4.0 Blanks (Laboratory and Field)

4.1 Were method blanks and instrument blanks prepared and/or analyzed at the appropriate frequency?(every 20 samples of similar matrix or each extraction batch) ☐ ☐ ☐

NOTE: If blank data are missing or not available, reject "R" all associated positive data. However, using professional judgement, the data reviewer may substitute field blank data for missing method blank data.

Yes No N/A

4.2 Were sample results verified as uncorrected for blank concentrations? ☐ ☐ ☐

4.3 Were all blanks evaluated for contamination? ☐ ☐ ☐

4.4 Were negative concentrations in the blanks evaluated? ☐ ☐ ☐

4.5 Do any method/instrument blanks have positive results? ☐ ☐ ☐

ACTION: If the blank result has an absolute value less than or equal to the reporting limit, no qualification of data is necessary.

- If the reported blank result is greater than or equal to the reporting limit, qualify all sample results greater than the reporting limit but < 5x the amount in any blank as undetected, "U." Sample results >5x the blank concentration require no qualification.

- If the blank result is negative, and the absolute value is greater than the reporting limit, all associated samples must be carefully examined. Sample results reported as positive, but <5x the absolute value of the blank shall be qualified as estimated "J," and sample results reported as undetected will be qualified as estimated "UJ."

- if gross contamination is present, the affected analyte in associated samples may be qualified as unusable, "R."

4.6 Do any field/rinse/equipment blanks have positive results? ☐ ☐ ☐

NOTE: All field blank results associated with a particular group of samples may be used to qualify data. Blanks may not be qualified because of contamination in another blank. Field blanks

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may be qualified because of calibration and LCS quality control problems.

- ACTION: If the sample result is greater than the RDL but $<5\times$ the blank result, qualify the sample result as nondetect, "U."
- If the sample result is less than the RDL but $<5\times$ the blank result, qualify the sample result as nondetect, "U."
 - If the sample result is greater than the RDL and $>5\times$ the blank result, no qualification is necessary.
 - If gross contamination exists, all data in the associated samples should be qualified as unusable "R."

5.0 QC Check Sample (LCS)

5.1 Have LCS results been included in the data package? ☐

5.2 Was the LCS prepared and analyzed at the appropriate frequency? ☐

Yes No N/A

5.3 Were percent recoveries within acceptance limits? ☐

NOTE: If laboratory-generated control limits or vendor-supplied limits are not provided, control limits of 80-120%R shall be used.

- ACTION: If the LCS recovery falls within the range of 50-79% or $>120\%$, qualify detected results as estimated, "J."
- If the LCS recovery is $>120\%$, nondetected results are acceptable and no qualification is required.
 - If the LCS recovery falls within the range of 50-79%, nondetected results are qualified as estimated, "UJ."
 - If the LCS recovery results are $<50\%$, qualify positive results as estimated, "J," and nondetected results as unusable, "R."

6.0 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

NOTE: Qualification must not be applied to sample data based on MS/MSD data alone, but should be used in conjunction with other QC parameters in judging data usability and the need for data qualification.

Spike recoveries should be within control limits generated by the laboratory. If laboratory-generated control limits are not provided, limits of 75-125%R shall be used.

Relative percent difference (RPD) between MS and MSD results must be within control limits

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generated by the laboratory. If laboratory-generated RPDs are not provided, control limits of $\pm 20\%$ RPD for aqueous samples and $\pm 35\%$ RPD for soil samples shall be used.

6.1 Have MS/MSD results been included in the data package? ☐ ___

6.2 Were the MS/MSD analyzed at the appropriate frequency for each of the following matrices?

Water? ☐ ___

Waste? ☐ ___

Soil/Solid? ☐ ___

6.3 Are MS/MSD percent recoveries within acceptance criteria? ☐ ___

ACTION: If the validator determines that data qualification is justified based on MS recoveries, the following guidance shall be used:

- If MS recoveries are above the upper control limit, qualify detected analytes as estimated, "J." (Nondetects do not require qualification)

- If MS recoveries are below the lower control limit, qualify detected analytes as estimated, "J," and nondetects as estimated, "UJ" or "R."

Yes No N/A

6.4 Are all MS/MSD RPDs within control criteria? ☐ ___

ACTION: If RPDs are outside control limits, qualify detected results as estimated, "J."

7.0 Field and Laboratory Duplicates

7.1 Were field duplicates collected and analyzed with these samples? ☐ ___

7.2 Were the field duplicate RPDs within acceptable control criteria? ☐ ___

NOTE: Field duplicate criteria for aqueous samples shall be less than 40% RPD. The field duplicate criteria for soil/solid samples shall be less than 70%.

ACTION: If the field duplicate is greater than 40% for aqueous samples or greater than 70% for soil/solid samples, qualify all detected results as estimated "J." (Nondetect results do not require qualification).

7.3 Were laboratory duplicates performed with each sample batch? ☐ ___

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7.4 Were laboratory duplicate RPDs within acceptable control limits? ☐ ☐ ☐

NOTE: If laboratory duplicate RPD is not established, use +/-20% for aqueous sample results, and +/-35% for soil/solid sample results.

ACTION: If laboratory duplicate RPD results are greater than 20% for aqueous samples, or greater than 35% for soil/solid samples, qualify all detected results as estimated "J." (Nondetect results do not require qualification).

8.0 Sample Result Verification

8.1 Are there any transcription/calculation errors in the Form I or equivalent results? Check at least two positive values. Were any errors found? ☐ ☐ ☐

NOTE: If the laboratory has a high rate of manual transcription in generation of sample results, the project team may choose to manually recalculate sample results at a determined frequency. If the sample results cannot be reproduced through manual calculation, contacting the laboratory may be necessary to resolve the problem. Data may be qualified as rejected "R" as a last resort if no actions can reproduce reported values.

8.2 Were reported results within the calibration range of the instrument? ☐ ☐ ☐ Yes No N/A

8.3 Were results from diluted samples corrected for the dilution factor? ☐ ☐ ☐

8.4 Are the RDLs or EDLs (estimated detection limits) adjusted to reflect sample dilutions and , for soils, %moisture? ☐ ☐ ☐

ACTION: When a sample is analyzed at more than one dilution, the lowest EDL/RDL are used. Replace concentrations that exceed the calibration range in the original analysis by crossing out the value on the original Form I or equivalent and substituting it with data from the analysis of the diluted sample. Specify which Form I or equivalent is to be used, then draw a red "X" across the entire page of all Form I's or equivalent that should not be used, including any in the summary package.

E

Appendix
E

APPENDIX E

DATA MANAGEMENT

Data Management

The ASC is responsible for tracking samples from the point of field collection to submittal for laboratory analysis and the subsequent data validation and data management efforts. The sample handling and custody requirements, including field logbook (TSOP 4-1) and generation of sample paperwork, sample labels and custody seals (TSOP 1-2) discussed in Sections 6.3 and 6.5, will be followed. The laboratory QA requirements including laboratory audits and contract compliance screening will be followed according to procedures described below and in Section 6.16. The ASC will receive non-RAS data from the laboratory and track it through the data validation process. For non-RAS data, the ASC will submit the electronic "ANSETS Data Requirement" form (Figure 6-11) to the RSCC by the first day of each month for the previous month's sampling. RAS data will be validated by EPA with contractor support; EPA will be responsible for tracking and maintaining custody of the laboratory data packages through the data validation process. When non-RAS data packages are received from the laboratory, the ASC will initiate a non-RAS Data Package Chain-of-Custody Form. All transfers of the data package from one individual to the next must be recorded on the custody record. The data package itself must remain under lock and key when not undergoing processing. Data validation performed by CDM will be in accordance with the procedures described in Section 6.12 of this QAPP. Once the data is validated, it will be input into CDM's database.

A project-specific electronic spreadsheet will be developed for sample tracking purposes prior to field activities. The tracking system will be initiated in the field during sample collection and will be updated during the sample analysis and data validation phases. The data will be entered by project staff and then checked by the ASC for accuracy. This tracking system will ensure that no data is lost during the data management process.

The following information is recorded in the tracking system:

Sample Number

- | | |
|-------|---|
| I. | Area of Concern |
| II. | Sample Matrix |
| III. | SDG Number |
| IV. | CLP Case No. |
| V. | CLP No. |
| VI. | Analytical Parameter |
| VII. | Collection Date |
| VIII. | Shipment Date |
| IX. | Date Received from Lab |
| X. | Date Submitted for Data Validation |
| XI. | Name of Data Validator |
| XII. | Date of Data Validation Completion |
| XIII. | Database Entry Date |
| XIV. | Database QC Date |
| XV. | Comments (i.e., MS/MSD designation, duplicate samples). |

Analytical data collected during the field effort will be entered into an appropriate relational database management system and standard commercial software packages. This management system will include both location and environmental data. Historical data and potentially responsible party data can also be entered. The database management system will

Data Management

provide data storage, retrieval, and analytical capabilities. The system will be able to meet a full range of site and media sampling requirements since it will be able to interface with a variety of spreadsheet, word processing, statistical, and graphics software packages.

To facilitate the use of the database, CDM will provide the laboratories with a detailed format specification for the delivery of analytical data in an electronic diskette deliverable (EDD). Once it is uploaded into the database, validated analytical data will be organized, formatted, and input into the database for use in the data evaluation phase. A 100 percent quality control check will be performed to ensure accuracy on all hand-entered data (i.e., data qualifiers added by CDM validators on subcontract laboratory data, sample field notations).

Data tables that compare the results of the various phases of sampling efforts will be prepared and evaluated. In addition, data tables that compare analytical results with both state and federal ARARs will be prepared. Analytical data results will interface with graphics packages to illustrate contaminants detected. As a quality control check, reports, tables, and graphical figures will be compared to the sample tracking system for errors and omissions. CDM will provide EPA with final analytical data on electronic media.

Data management will utilize personal computers (PC), local area networks (LAN), and electronic communications (ex: the World Wide Web) to support the database management system software. CDM will set up PC stations on which the database management system and commercial software will run in compliance with those software licensing requirements. CDM will take reasonable care to protect the data and will perform periodic backups to prevent wholesale loss of project data. Control of the computer hardware and software will be as per CDM QP 4.1.

After the CLP data has been validated, the package is returned to the EPA RPM. CLP data packages forwarded to CDM ACS will then have copies made of the Region II chain-of-custody/data transfer log, validated Form Is, data validation assessment and data validation checklist for distribution to the site manager and RAC II document control files. The original CLP data package with all associated forms is retained by EPA for archival. Non-CLP data packages received from the RAC II BOA laboratory subcontractor are sent for data validation, then returned to the ASC. These packages are copied and distributed to the site manager and RAC II document control files. Copies of the non-CLP data packages will be submitted to EPA during project close-out.

F

Appendix F

APPENDIX F
FIELD FORMS

INDOOR AIR QUALITY BUILDING SURVEY

Occupant/Building Name: _____ Date: _____

Address: _____

Telephone No. Home _____ Work _____ Best time to contact _____

Completed by: _____

Canister # _____ Time Started: _____ Time Stopped: _____

Location: _____

Canister # _____ Time Started: _____ Time Stopped: _____

Location: _____

Canister # _____ Time Started: _____ Time Stopped: _____

Location: _____

Canister # _____ Time Started: _____ Time Stopped: _____

Location: _____

Daily Weather Conditions: Temperature _____ Relative Humidity _____

Are you the ☐ Owner, ☐ Renter, ☐ Other (please specify) _____ of this Home/Structure?

Total number of occupants/persons at this location? _____, Children under age 13 _____, Children age 13-18 _____.

How long have you lived at this location? _____.

Do you regularly use air fresheners? ☐ Yes, ☐ No.

Do you regularly use or work in a dry cleaning service (check only one box)? ☐ Yes, use dry-cleaning regularly (at least weekly), ☐ Yes, use dry-cleaning infrequently (monthly or less)? If yes, when was the last time you brought home dry cleaned clothes? _____ ☐ Yes, work at a dry cleaning service, ☐ No

Does anyone in your home use solvents at work? ☐ Yes, ☐ No. If yes, are the work clothes washed at home? ☐ Yes ☐ No

What is the source of your drinking water? ☐ Public water supply, ☐ Private well, ☐ Other _____

Do you have a private well for purposes other than drinking? ☐ Yes, ☐ No

Do you have a septic system? ☐ Yes, ☐ No, ☐ Not used, ☐ Unknown

Do you have standing water outside your home (pond, ditch, swale)? ☐ Yes, ☐ No

Where is the washer/dryer located? ☐ Basement, ☐ Upstairs utility room, ☐ Garage, ☐ Other _____

Do you have air conditioning? Yes ☐ No ☐. If yes, please check the appropriate type(s) ☐ Central air conditioning, ☐ Window air conditioning unit(s), ☐ Other ☐, please specify _____

Do you use any of the following? Room fans ☐, Ceiling fans ☐, Attic fan ☐

Water Heater Type: ☐Gas, ☐Electric, ☐Other_____

Water heater location: ☐Basement, ☐Upstairs utility room, ☐Garage, ☐Other_____

What type of cooking appliance do you have? ☐Electric, ☐Gas, ☐Other_____

Type of Home/Structure (check only one): ☐Single Family Home, ☐Duplex, ☐Condominium, ☐Townhouse,
☐office, ☐commercial, ☐industrial, ☐Other_____

Number of floors below grade: _____, at or above grade: _____

Does this structure have a ☐Basement, ☐Crawlspace or Slab?

Basement/Crawlspace size: _____ ft³

Number of rooms in the basement: _____

OUTSIDE SOURCES	Yes	No	Comments/Locations
Garbage dumpsters			
Heavy motor vehicle traffic			
Construction activities			
Nearby industries (identify)			
UST/AST (gasoline, heating fuel)			
BASEMENT SURVEY			
Wall construction (cinder block, poured concrete, sheet rock, paneling, etc.)			type: condition:
Floor Construction (earthen, slab, floating, etc)			type: condition:
Number of windows present on each wall and size			North: East: South: West:
Was basement painted recently? oil-base or latex paints			date: type of paint:
Is the basement <input type="checkbox"/> finished <input type="checkbox"/> or unfinished? If finished, how many rooms are in the basement?_____	YES	NO	
Does the basement have any of the following? (check all that apply) <input type="checkbox"/> Sump <input type="checkbox"/> Floor drain <input type="checkbox"/> Other hole/opening in floor <input type="checkbox"/> (describe)_____			Notes:
Describe the location of any above appurtenances:			Notes:
Do pipes connect to the sump? (french drain?)			

New flooring in basement?(list type - carpet, tile)			
Has glue been used for construction or hobbies?			
New furniture added to basement			type: date:
Staining on floors/walls			
	YES	NO	
Moisture visually present in the basement			
Pipes running through walls, floor (conduits-describe, give FID/PID/CGS readings)			
Odors detected by inspector			
Basement used as living space			
Time occupants spend in basement (hours/day/per person)			
Items stored in basement:			
solvents			
gasoline			
paint/thinners			
polishes/waxes			
insecticides			
kerosene			
household cleaning products			
mothballs			
other items?			
NOTES: _____ _____ _____			
FIRST FLOOR SURVEY			
Wall construction (cinder block, sheet rock, paneling, etc)			type: condition:
Was painting done recently? oil-base or latex?			date: type of paint:
New flooring on 1 st floor? (list type - carpet, tile)			
Has glue been used for construction or hobbies?			

New furniture added to 1 st floor? (list type - carpet, tile)			type: date:
Staining on floors/walls			
Pipes running through walls, floor (describe)			
Odors detected by inspector			
	YES	NO	
Items stored on this floor			
	YES	NO	
solvents			
gasoline			
paint/thinners			
polishes/waxes			
insecticides			
kerosene			
household cleaning products			
mothballs			
other items?			
NOTES: _____ _____ _____			
PERSONAL ACTIVITIES			
Does anyone in the building smoke?			
approx. number of tobacco products per day, per person			
List hobbies of Residents			
Any house pets?			
MISCELLANEOUS			
Have the occupants ever noticed unusual odors inside or outside the building ?			describe: location:
Known spill outside or inside building (Specify location)			

Type of heating used in building oil - (identify the location and age of the storage tank)					
natural gas					
electric					
other (specify)					
Is the heating unit properly vented?					
Water damage or standing water in building (historic or current)					
Fire damage to building			date:		
Pest control applications			date:		
	YES	NO			
FIELD SCREENING RESULTS	FID	PID	CGI	CO2	Rel. Hum
Basement					
First Floor					
Additional Floors					
Other (specify) _____					
NOTES:					

NOTES: _____



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION II

The United States Environmental Protection Agency (EPA) is conducting an investigation of indoor air quality in and around residential homes in your area. Concerns over contamination in the ground water, allegedly linked to a metal cleaning operation, has initiated this action. As a result, EPA is collecting indoor air samples from residences in the vicinity of the site.

INDOOR AIR SAMPLING

Why is the United States Environmental Protection Agency collecting air samples from my basement?

To determine if contamination in the ground is affecting homes, EPA is testing indoor air quality. As a result, EPA personnel will collect a sample of the air from your basement and analyze it at no charge to you. The sampling event is to determine whether you and/or your family are at risk of breathing harmful contaminants that may be associated with subsurface contamination.

How is the air being collected from my basement?

A device, known as a Summa Canister, will be placed in your basement to draw in air for a period of 24 hours. Initially, the summa canister is under a vacuum. The summa canister will be opened in your basement and air will flow into the canister for 24 hours. Air will not flow out of the device. These canisters are completely safe and pose no danger to you or your children.

*What should I **NOT DO** so that I do not damage or disrupt the summa canister and provide the proper environment for the sampling event?*

Summa canisters are particularly sensitive, and can be damaged very easily. This is why it is important to practice the following precautions at least 24 hours prior to sampling:

- do not smoke in the basement or house
- do not open the basement door
- do not bring dry-cleaning into the house
- do not use solvents of any type
- do not open your basement windows
- do not utilize fans or vents in the basement
- do not paint or clean paint brushes
- do not polish your shoes
- do not pour gasoline, liquid fuels or solvent inside your house or attached garage
- do not park your car inside your attached garage
- do not start internal combustion equipment inside your house or attached garage
- do not run the clothes washer or dryer if in the basement
- do not move the canister(s) under any circumstances.

Who is doing the analysis of the samples?

Although EPA personnel will be providing oversight of the work conducted on your premises, EPA contractors will be collecting the air samples and a private laboratory has been contracted to perform the analytical procedures.

EPA apologizes for any inconveniences that may occur as part of this sampling event. However, your cooperation and understanding is greatly appreciated. Remember, we are doing this for the protection of your health, as well as the surrounding community's.

Please call Lorenzo Thantu at (212) 637-4240 with any questions about the sampling itself or any additional questions you may have. Thank you for your help and cooperation.

DAILY SIGN-IN SHEET
MAUNABO GROUNDWATER CONTAMINATION SITE

Date	Print Name	Signature	Affiliation	Time On-Site	Time Off-Site

DRILLING SUMMARY SHEET
MAUNABO GROUNDWATER CONTAMINATION SITE

Date:
Geologist:
Driller:
Borehole Locations:
Drums Generated (ID#s):

	1.0 GENERAL CHARGES		HAS RIG	TRIPOD
1a.	Mobilization and Demobilization	Each		
1b.	Construct Decontamination Pad	Each		
1c.	Steam Cleaning (1 hour/boring maximum)	Hours		
1d.	Drums	Drums		
1e.	Drumming Residuals/Transportation	Drums		
1f.	Standby Time	Hours		
1g.	Baker Tank Rental (20,000 gallons each)	Each		
2.0 BOREHOLE DRILLING				
2a.	4 ¼ inch ID – HSA	Feet		
2b.	Split Spoon Sampling	Spoons		
2c.	Shelby Tubes	Tubes		
2d.	Geoprobe Boreholes	Feet		
2e.	Macro Core and Large Bore Sampling	Feet		
2f.	Soil Boring with Tripod	Feet		
2g.	Borehole Grouting	Feet		
3.0 OVERBURDEN MONITORING WELL INSTALLATION				
3a.	Soil Borings with 6 ¼ inch ID HAS (8 inch borehole)	Feet		
3b.	Split Spoon Sampling	Spoons		
3c.	4-inch Type 304 Stainless Steel Casing	Feet		
3d.	4-inch Type 304 Stainless Steel Screen	Feet		
3e.	Well Completion Materials (Gravel pack, bentonite, grouting installed)	Feet		
3f.	5 foot Carbon Steel Protective Casing (installed), including Well Lock and Key, Concrete Collar, etc.	Each		
3g.	Flush Mount including Well Lock and Key, Concrete Collar, etc.	Each		
3h.	Well Development (3 hours/well)	Wells		
4.0 OVERBURDEN MONITORING WELL INSTALLATION				
4a.	Surcharge for Level "C"	Per Hour		

**GENERAL EQUIPMENT CALIBRATION LOG
MAUNABO GROUNDWATER CONTAMINATION SITE**

Instrument (make/model/serial #): _____ Manufacturer: _____ Rental Company: _____

Upon receipt, all parts are included and this instrument is in working order: _____
(signature/date)

Calibration Date	Initial Setting	Standard/ Gas Used (Concentration)	Lot Control No. Expiration Date	Adjustments Made	Final Reading	Comments Pass/Fail	Signature

REV 5/01

R2-0000675

EQUIPMENT LIST
MAUNABO GROUNDWATER CONTAMINATION SITE

Item	Unit*	Quantity
Acetone - Pesticide Grade (4 liter bottle) 4/case		
Acid, hydrochloric - Optima		
Acid, nitric - Optima		
Acid, nitric - 2.5L 10% Solution		
Bags, garbage (200/case)		
Bags, ZipLock - large 10x12 (1000/case)		
Bags, ZipLock - small 8x8 (1000/case)		
Book, log / Rite in the Rain Environmental No. 550		
Boot Covers (yellow) - XXL		
Bottle - En Core Sampler		
En Core - Standard T-Handle		
Bottle, 60 ml welded septa clear jars (24/case)		
Bottle, amber, 1-liter (12/case)		
Bottle, poly 100 ml (48/case - temp. blanks) - not certified clean		
Bottle, poly 1-liter (12/case)		
Bottle, short clear wide mouth 250ml (24/case)		
Bottle, glass vial, 40-ml (72/case)		
Bottles, Squirt (decon - nitric)		
Bottles, Spray (decon - acetone)		
Calibration Gas (Isobutylene)		
Calibration Gas, Pentane 50% Span R-SGPEN 17Ltr		
Camera, disposable		
Can, gas (OSHA)		
Caution Tape		
Custody Seals (100/pack)		
Drums, Waste PPE/Purge Water		
Ear Plugs		
Eye Saline Solution for large Eye Wash Station		
Eyeglasses, safety		
Eyewash (Portable)		
Film Developing		
Flagging Tape		
Foil, aluminum (12"x1000') standard weight		

* For example, a unit can be a case, liter, or a dozen.

Item	Unit*	Quantity
Gloves, Cotton Liners (12/pack)		
Gloves, Nitrile 12 inch size 10 (12/bag, 144 per case)		
Gloves, Nitrile disposable		
Gloves, Surgical (latex) (100 per box, 2000 per case)		
Gloves, Work (cotton)		
GMCH Cartridge (respirator)		
Ice		
Knife, utility		
Liquidnox (1 gallon bottle)		
Markal Paintstik B		
Paper, PH Double-Roll Dispenser (1-14)		
Pens, ball point		
Pens, Sharpies		
Pipet - Standard Bulb Pipet (500/case)		
Plain Vinyl Flags		
Poly Sheeting (12'x100' - 4 mil.)		
Rope, poly (for pumps) 1/4"		
Sodium Hydroxide		
Stakes, Wooden, 3' bundle of 50		
Stay Ties (100 ct)		
Tape, clear		
Tape, duct		
Tape, electrical		
Tape, strap (48 rolls/case)		
Tape, Measuring (200') Fiberglass Keson Open Reel		
Tape, Measuring (300') Fiberglass Keson Open Reel		
Tarp, plastic		
Teflon Lined Tubing		
Towels, paper (30 ct)		
Tubes, Draeger (10/carton)		
Tubing, Polyethylene		
Tyvek (Standard Coveralls w/Hood, Elastic Wrists & Ankles - XX Large, 25/case)		
Vermiculite Medium Grain		
Water, Deionized (5 gal)		
Water, Reagent Grade 4 liter bottle (4/case)		

* For example, a unit can be a case, liter, or a dozen.

Item	Unit*	Quantity
Wipes, respirator (100/carton)		
Balances, Electronic		
Boots, hipwaders		
Boots, Latex		
Boots, Slush		
Bowls, Stainless Steel		
Box Clipboard		
Bucket, w/cover (5 gallon)		
Bulletin Board		
Cans, water (5 gallon)		
Coolers - Large		
Coolers - Medium		
Coolers - Small		
Crab Traps		
Cutters, bolt		
Decon Tub 14 Gal Rubbermaid		
Dry - Erase board		
Eyewash Station (15 min)		
Fire extinguisher		
First Aid Kit		
Folding Rules, Lufkin Red End Engineer's		
Gauge, Rain		
Inverter 550		
Munsell Color Chart		
Portable UV light & replacement light tube		
Refrigerator		
Scale, Engineer		
Scrub brush, long handle		
Scrub brush, short handle		
Scrub brush - toilet		
Scrub brush - bottle		
Scupula Spatulas		
Spoons, Stainless Steel		
Stainless Steel Sprayer		
Plastic Sprayer		

* For example, a unit can be a case, liter, or a dozen.

**MAUNABO GROUNDWATER CONTAMINATION SITE
FERROUS IRON HACH TEST RESULTS**

HACH Model No.: _____

Date	Time of Run	Sample ID	Sample Collection Time	Sample Volume* (V1)	Final Volume* (V2)	Dilution (V2/V1)	Instrument reading	Second Reading ³ (mg/L)	Final Result **

QA/QC Requirement = 1 duplicate per 20 samples analyzed (Refer to QAPP for requirement)

Notes:

1. Record all notes on this form and in the Site log book. You should be recording them throughout the day as you do them - not just a summary at the end of the day.
2. Note if samples are turbid.
3. Second reading does not need to be done on all samples - just every 5th or 6th sample. Used to make sure the instrument is functioning correctly.
4. Duplicate samples will be collected and run independently (e.g. NJDEP-MW10-R3 is the dup. of NJDEP-MW1-R3), record as separate samples. Duplicates shall be performed with each batch of analyzed samples.
5. 3.0 mg/L is the upper limit (this limit is subject to change - please verify with procedure manual). If you receive this reading record it with the word "LIMIT" and you will need to perform a dilution.
6. Record the volume of sample taken for dilution and record the final volume, For example, for a 1 ml sample and 10 ml final volume, the dilution is V_2/V_1 or 10. The result shall be multiplied by ten. Make sure to record the instrument reading and then adjust the result for the dilution factor.
7. You should run a sample of the reagent grade water that you will use for dilutions, try to use the same bottle through the sampling event unless the reagent grade water lot changes.

* Don't forget - a 10% dilution result needs to get multiplied by 10, and a 25% dilution result gets multiplied by 4.

Write out the reading from the instrument and then show the math on the sheet.

You will also need to record this in your logbook.

** Final result corrected for dilution
Final results = Instrument Reading x V_2 / V_1
If Dilution = 1, then Final Reading = Instrument Reading

QA/QC Requirement = 1 duplicate per 20 samples analyzed (Refer to QAPP for requirement)

**RAC II
MAUNABO GROUNDWATER CONTAMINATION SITE
FIELD CHANGE REQUEST (FCR) FORM**

REQUEST NO: _____ DATE: _____

FCR TITLE: _____

DESCRIPTION: _____

REASON FOR DEVIATION: (Include impact on project objectives)

RECOMMENDED/MODIFICATION: _____

INCLUDE IMPACT ON PROJECT OBJECTIVES: _____

Signatures: _____

Field Team Leader (FTL)

Date

CDM Site Manager (SM)

Date

Distribution: EPA Remedial Project Manager
CDM SM
Regional Quality Assurance Coordinator
Field Team
Project File

**MAUNABO GROUNDWATER CONTAMINATION SITE
LOW FLOW GROUNDWATER SAMPLING PURGE RECORD**

DATE:

WELL #:

SAMPLERS:

DEPTH OF PUMP INTAKE:

ft TIC or ft BGS (circle one)

WEATHER CONDITIONS:

SCREENED/OPEN BOREHOLE INTERVAL:

ft TIC or ft BGS
(circle one)

SAMPLE ID:
CLP ID:

SAMPLE TIME:

SAMPLE FLOW RATE:

ml/minute

Instrument Type/Model: Complete and/or Circle at right					YSI Model # _____ / Horiba U-22 (circle one) Other (specify) _____					Instrument:
CURRENT TIME	VOLUME PURGED	DEPTH TO WATER	FLOW RATE	DRAWDOWN (± 0.3 FT)	pH (± 0.1 SU)	SPECIFIC CONDUCTIVITY (± 3%)	DISSOLVED OXYGEN (± 10%)	TEMP. (± 10%)	REDOX POTENTIAL (± 10 mV)	TURBIDITY (± 10%)
24-Hour	gallons / liters (circle one)	ft TIC / ft BGS (circle one)	Units:	ft TIC / ft BGS (circle one)	SU	S/cm, mS/cm ^o or µS/cm (circle one)	mg/L (not %)	Units: °C	mV	NTUs

Drawdown is not to exceed 0.3 feet. Flow rate should not exceed 500 ml/min during purging or 250 ml/min during sampling. Readings should be taken every three to five minutes. The well is considered stabilized and ready for sampling when the indicator parameters have stabilized for three consecutive readings by the measurements indicated in parenthesis.

Typical values: DO = 0.3 - 10 mg/L Redox Potential = -100 - +600 mV Turbidity = 0 - >500 NTUs
Spec. Conductivity (µS/cm) = 0.01 - 5,000; up to 10,000 in industrial, ~55,000 in high salt content water. Note: 1,000 µS/cm = 1 mS/cm

TIC = Top of Inner Casing BGS = Below Ground Surface

R2-0000683

ONSITE SCREENING TRACKING LOG

SITE NAME: MAUNABO GROUNDWATER CONTAMINATION SITE

SAMPLE ID	SAMPLE DATE	SAMPLE TIME	MATRIX	DUPLICATE (Y/N)	OFFSITE (Y/N)	COMMENTS

PHOTOLOG

SITE NAME: MAUNABO GROUNDWATER CONTAMINATION SITE

CAMERA # _____

Photograph #	Description	Date/Time	Photographer

**SAMPLE TRACKING LOG
MAUNABO GROUNDWATER CONTAMINAITON SITE**

LDL VOC LAB: _____ INORGANIC CLP LAB: _____

CLP CASE NO: _____ ORGANIC CLP LAB: _____ SUBCONTRACT LAB: _____

SAMPLE ID	SAMPLE DATE	SAMPLE TIME	MATRIX	DEPTH (feet)	LDL VOC CLP NO.	ORGANIC CLP NO.	INORGANIC CLP NO.	SUBCONTRACT ANALYSIS	QA/QC

ANALYSIS SUMMARY: _____

SUBCONTRACTOR LABORATORY SAMPLE TRACKING LOG

SITE NAME: MAUNABO GROUNDWATER CONTAMINATION SITE

DATE SHIPPED OR RECEIVED	NUMBER OF SAMPLES SHIPPED (OR SUPPLIES RECEIVED)	ANALYTICAL PARAMETERS REQUIRED	NUMBER OF COOLERS SHIPPED

G

Appendix G

Appendix G

DESA Requirements

Measurement Performance Criteria Table

Matrix	Aqueous/Soil				
Analytical Group¹	Semi-Volatiles				
Concentration Level					
Sampling Procedure²	Analytical Method/SOP³	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
NA	See worksheet #28 & #23	Precision	% RPD < 30	LCS Duplicate	A
		Accuracy	Compound Specific (full range: D-262%)		
		Accuracy	Factor of two(-50% to + 100%) from the initial/continuing calibration	Internal standards	A
		Accuracy	Compound Specific (full range: D-262%)	Matrix spike	A
		Accuracy	Limits 30%-120% for Base Neutrals Limits 20%-120% for Acids	Surrogate Compounds	A
		Accuracy	< RL	Method Blank	A

Measurement Performance Criteria Table

Matrix	Aqueous/Soil				
Analytical Group¹	Metals/Mercury				
Concentration Level	Low				
Sampling Procedure²	Analytical Method/SOP³	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
NA	See #28/ #23	Precision	% RPD < 20(Aq), % RPD <25(Soil)	LCS Duplicate	A
		Accuracy	Limits: Average Recovery \pm 20% aqueous, \pm 25% Soil)	LCS	A
		Accuracy	\pm 20% aqueous, \pm 25% Soil)	Matrix spike	A
		Precision	< RL Except for Al, Fe, Ca, K, Mg and Na	Interference Check Sample(ICP/AES)	A
		Accuracy	< RL	Method Blank	A
		Precision	RPD < 20 %	Serial Dilution Test(ICP/AES)	A
		Accuracy	Range of 0.60-1.87 of the original response in the calibration blank	Internal Standards(ICP-MS)	A

QAPP Worksheet #12
(UFP-QAPP Manual Section 2.6.2)

Title:
Revision Number:
Revision Date:
Page ____ of ____

Measurement Performance Criteria Table

Matrix	Aqueous/Soils				
Analytical Group¹	Microbiology				
Concentration Level	N/A				
Sampling Procedure²	Analytical Method/SOP³	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
NA	See worksheets #28/ #23	Media selectivity,sensitivity	Growth promotion	LCS(Positive Control)	A
		Precision	10% (different analyst) 5%(same analyst)	Sample Duplicates Count	A
		Contamination	No growth	Method Blank	A
		Media /containers selectivity,sensitivity Contamination	No growth	Sterility or Performance Testing	A

QAPP Worksheet #12
(UFP-QAPP Manual Section 2.6.2)

Title:
Revision Number:
Revision Date:

Measurement Performance Criteria Table

Matrix	Aqueous/Soil				
Analytical Group¹	Pest/PCB				
Concentration Level					
Sampling Procedure²	Analytical Method/SOP³	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
NA	See worksheets #28/ #23	Precision Accuracy	% RPD < 30 Average Recovery 50-150%	LCS Duplicate	A
		Accuracy	Compound Specific (full range: 30-150%)	Matrix spike	A
		Accuracy	Limits 30%-150%	Surrogate Compounds	A
		Accuracy	< RL	Method Blank	A

QAPP Worksheet #12
(UFP-QAPP Manual Section 2.6.2)

Title:
Revision Number:

Measurement Performance Criteria Table

Matrix	Aqueous/Soil				
Analytical Group¹	Sanitary				
Concentration Level	Low				
Sampling Procedure²	Analytical Method/SOP³	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
NA	See worksheets #28/ #23	Precision	% RPD < 20	LCS Duplicates	A
		Accuracy	90-110% or manufacturer limits	LCS	A
		Accuracy	± 20%	Matrix Spike	A
		Precision	% RPD < 20	Sample Duplicates	A
		Accuracy	< RL	Method Blank	A

Measurement Performance Criteria Table

Matrix	Aqueous/Soil				
Analytical Group¹	VOA				
Concentration Level	Low(aq)/Medium(soil)				
Sampling Procedure²	Analytical Method/SOP³	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
NA	See worksheets #28/ #23	Precision Accuracy	% RPD < 20 Average Recovery 70-130%	LCS Duplicate	A
		Accuracy	Factor of two(-50% to + 100%) from the initial/continuing calibration	Internal standards	A
		Accuracy	Compound Specific (full range: 17-259%)	Matrix spike	A
		Accuracy	Limits 70%-130%(Aqueous) Table 7 of C-123(low Soil)	Surrogate Compounds	A
		Accuracy	< RL	Method Blank	A

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group¹	VOA				
Concentration Level	Trace				
Sampling Procedure²	Analytical Method/SOP³	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
NA	See worksheets #28/ #23	Precision Accuracy	% RPD < 20 Average Recovery(80-120%)	LCS Duplicate	A
		Accuracy	+/- 40% from the initial/continuing calibration	Internal standards	A
		Accuracy	Limits 70%-130%	Matrix spike	A
		Accuracy	Limits 80%-120%	Surrogate Compounds	A
		Accuracy	< RL	Method Blank	A

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Metals-ICP/AES
Concentration Level:

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQLs µg/l	Achievable (DESA) Limits ²	
				MDLs µg/l	RLs µg/l
Aluminum	7429-90-5		200	93.9	200
Antimony	7440-36-0		60	0.71	20
Arsenic	7440-38-2		10	2.26	8
Barium	7440-39-3		200	0.83	6
Beryllium	7440-41-7		5	0.24	5
Cadmium	7440-43-9		5	0.11	4
Calcium	7440-70-2		5000	68.0	1000
Chromium	7440-47-3		10	0.22	6
Cobalt	7440-48-4		50	0.18	8
Copper	7440-50-8		25	5.89	10
Iron	7439-89-6		100	35.6	100
Lead	7439-92-1		10	1.18	7
Magnesium	7439-95-4		5000	30..5	1000
Manganese	7439-96-5		15	0.07	5
Mercury	7439-97-6		0.2	.017	0.2
Nickel	7440-02-0		40	0.46	5
Potassium	7440-09-7		5000	53.3	1000
Selenium	7782-49-2		35	1.34	7
Silver	7440-22-4		10	.030	6
Sodium	7440-23-5		5000	161	1000
Thallium	7440-28-0		25	1.62	20
Vanadium	7440-62-2		50	2.14	10
Zinc	7440-66-6		60	4.84	8

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Metals-ICP/MS
Concentration Level:

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQLs µg/l	Achievable (DESA) Limits ²	
				MDLs µg/l	RLs µg/l
Aluminum	7429-90-5		-	1.19	10
Antimony	7440-36-0		2	0.022	2.0
Arsenic	7440-38-2		1	0.062	1.0
Barium	7440-39-3		10	0.031	1.0
Beryllium	7440-41-7		1	0.010	1.0
Cadmium	7440-43-9		1	0.009	1.0
Calcium	7440-70-2		-		-
Chromium	7440-47-3		2	0.314	1.0
Cobalt	7440-48-4		1	0.015	1.0
Copper	7440-50-8		2	0.315	1.0
Iron	7439-89-6		-		-
Lead	7439-92-1		1	0.011	1.0
Magnesium	7439-95-4		-		-
Manganese	7439-96-5		1	0.135	1.0
Mercury	7439-97-6		-		-
Nickel	7440-02-0		1	0.471	1.0
Potassium	7440-09-7		-		-
Selenium	7782-49-2		5	0.183	5.0
Silver	7440-22-4		1	0.007	1.0
Sodium	7440-23-5		-		-
Thallium	7440-28-0		1	0.013	1.0
Vanadium	7440-62-2		1	0.082	1.0
Zinc	7440-66-6		2	0.165	1.0

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Metals
Concentration Level:

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQLs mg/kg	Achievable (DESA) Limits ²	
				MDLs - mg/kg	RLs - mg/kg
Aluminum	7429-90-5		20	*	100
Antimony	7440-36-0		6	0.22	2
Arsenic	7440-38-2		1	0.35	0.8
Barium	7440-39-3		20	0.24	10
Beryllium	7440-41-7		0.5	0.02	0.3
Cadmium	7440-43-9		0.5	0.02	0.3
Calcium	7440-70-2		500	12.57	50
Chromium	7440-47-3		1	0.34	0.5
Cobalt	7440-48-4		5	0.03	2
Copper	7440-50-8		2.5	0.26	1
Iron	7439-89-6		10	*	5
Lead	7439-92-1		1	0.23	0.8
Magnesium	7439-95-4		500	5.06	50
Manganese	7439-96-5		1.5	0.33	0.5
Mercury	7439-97-6		0.1	.0043	0.05
Nickel	7440-02-0		4	0.09	2
Potassium	7440-09-7		500	12.36	50
Selenium	7782-49-2		3.5	0.22	2
Silver	7440-22-4		1	0.06	0.5
Sodium	7440-23-5		500	22.48	100
Thallium	7440-28-0		2.5	3.14	2
Vanadium	7440-62-2		5	0.40	2
Zinc	7440-66-6		6	1.57	2

* MDL study cannot be successfully performed on these analytes because of high background levels in matrix (sand).

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: PEST/PCBs
Concentration Level:

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs µg/kg	Achievable (DESA) Limits ²	
				MDLs µg/kg	RLs µg/kg
alpha-BHC	319-89-6		1.7	2.15	2.5
gamma-BHC	58-89-9		1.7	1.89	2.5
beta-BHC	319-85-7		1.7	1.35	2.5
delta-BHC	319-86-8		1.7	1.51	2.5
Heptachlor	76-44-8		1.7	2.05	2.5
Aldrin	309-00-2		1.7	1.66	2.5
Heptachlor epoxide	1024-57-3		1.7	1.34	2.5
Gamma-chlordane	5103-74-2		1.7	0.96	2.5
alpha-chlordane	5103-71-9		1.7	1.01	2.5
Endosulfan I	1031-07-8		1.7	1.16	2.5
4,4'-DDE	72-55-9		3.3	1.92	5.0
Dieldrin	60-57-1		3.3	1.91	5.0
Endrin	72-20-8		3.3	1.84	5.0
4,4'-DDD	72-54-8		3.3	1.35	5.0
Endosulfan II	1031-078		3.3	1.27	5.0
4,4'-DDT	50-29-3		3.3	1.52	5.0
Endrin aldehyde	7421-93-4		3.3	2.24	5.0
Methoxychlor	72-43-5		17	8.00	25
Endosulfan sulfate	1031-07-8		3.3	1.24	2.5
Endrin ketone	53494-70-5		3.3	1.18	2.5
Toxaphene	8001-35-2		170	75.9	190
Technical chlordane				56.1	62
AROCLOR 1016	12674-11-2		33		31
AROCLOR 1221	11104-28-2		33		62
AROCLOR 1232	11141-16-5		33		31
AROCLOR 1242	53469-21-9		33	29.9	31
AROCLOR 1248	12672-29-6		33		31
AROCLOR 1254	11097-69-1		33		31
AROCLOR 1260	11096-82-5		33		31
AROCLOR 1262	37324-23-5		33		31
AROCLOR 1268	11100-14-4		33		31

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: PEST/PCB Aroclors
Concentration Level:

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQLs $\mu\text{g/L}$	Achievable (DESA) Limits ²	
				MDLs $\mu\text{g/L}$	RLs $\mu\text{g/L}$
alpha-BHC	319-89-6		0.050	0.001	0.0025
gamma-BHC	58-89-9		0.050	0.001	0.0025
beta-BHC	319-85-7		0.050	0.002	0.0025
delta-BHC	319-86-8		0.050	0.002	0.0025
Heptachlor	76-44-8		0.050	0.001	0.0025
Aldrin	309-00-2		0.050	0.001	0.0025
Heptachlor epoxide	1024-57-3		0.050	0.005	0.0025
Gamma-chlordane	5103-74-2		0.050	0.001	0.0025
Alpha-chlordane	5103-71-9		0.050	0.002	0.0025
Endosulfan I	1031-07-8		0.050	0.002	0.0025
4,4'-DDE	72-55-9		0.10	0.003	0.005
Dieldrin	60-57-1		0.10	0.004	0.005
Endrin	72-20-8		0.10	0.004	0.005
4,4'-ddd	72-54-8		0.10	0.005	0.005
Endosulfan II	1031-078		0.10	0.004	0.005
4,4'-DDT	50-29-3		0.10	0.004	0.005
Endrin aldehyde	7421-93-4		0.10	0.006	0.005
Methoxychlor	72-43-5		0.50	0.032	0.050
Endosulfan sulfate	1031-07-8		0.10	0.004	0.005
Endrin ketone	53494-70-5		0.10	0.004	0.005
Toxaphene	8001-35-2		5.0	0.049	0.1875
Technical chlordane				0.020	0.0625
AROCLOR 1016	12674-11-2		1.0		0.03125
AROCLOR 1221	11104-28-2		1.0		0.0625
AROCLOR 1232	11141-16-5		1.0		0.03125
AROCLOR 1242	53469-21-9		1.0	0.020	0.03125
AROCLOR 1248	12672-29-6		1.0		0.03125
AROCLOR 1254	11097-69-1		1.0	0.014	0.03125
AROCLOR 1260	11096-82-5		1.0		0.03125
AROCLOR 1262	37324-23-5		1.0		0.03125
AROCLOR 1268	11100-14-4		1.0		0.03125

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Sanitary Chemistry
Concentration Level:

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLS ⁵	Achievable (DESA) Limits	
				MDLs mg/L	RLs mg/l
Alkalinity	471-34-1			0.11	1.0
Ammonia	7664-41-7			0.010	0.05
Chloride	16887-00-6			0.54	1.0
COD				8.89	20
Cyanide	57-12-5		10 µg/L	1.29 µg/l	5.0 µg/l
Fluoride (IC)				0.0040o	0.10
Fluoride (ISE)	016984488			.036	1.00
Hexavalent Chromium	018540299			6.21 µg/l	10.0 µg/L
Nitrite (NO2) (as N)	014797650			0.010	0.05
Nitrite (NO2) (as N) IC				0.0030	0.10
Nitrate (NO3) (as N)	014797558			0.010	0.05
Nitrate (NO3) (as N) IC				0.050	0.10
Nitrite + Nitrate (as N)	7727-37-9			0.0020	0.05
O-PO4	14265-44-2			0.0030	0.01
OP04 (IC)				0.039	0.10
Oil and Grease(Hexane extractable Material)				1.280	5.0
TPH(Silica-Gel treated Hexane Extractable material)				4.66	5.0
TSS				N/A	10
BOD	E1640606			N/A	2.0
Total Phenols				7.13 µg/l	10.0 µg/l
Sulfate	14808-79-8			1.34	5.0
Total Phosphorus	77723-14-0			0.0060	0.05
TKN				0.070	0.10
Sulfide				0.0090	0.05
TOC	10-19-5			0.19	1.0

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Semi -Volatile Organic Compounds
Concentration Level: low

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs ⁵ µg/kg	Achievable (DESA) Limits ²	
				MDLs µg/kg	RLs µg/kg
Benzaldehyde	100-52-7		170		120
Phenol	108-95-2		170		120
Bis(2-chloroethyl)ether	111-44-4		170		120
2-Chlorophenol	95-57-8		170		120
2-Methylphenol	95-48-7		170		120
Bis(2-chloroisopropyl)ether	108-60-1		170		120
Acetophenone	98-86-2		170		120
4-Methylphenol	106-44-5		170		120
N-Nitroso-di-n-propylamine	621-64-7		170		120
Hexachloroethane	67-72-1		170		120
Nitrobenzene	98-95-3		170		120
Isophorone	78-59-1		170		120
2-Nitrophenol	88-75-5		170		120
2,4-dimethylphenol	105-67-9		170		120
Bis(2-chloroethoxy)methane	111-91-1		170		120
2,4-dichlorophenol	120-83-2		170		120
Naphthalene	91-20-3		170		120
4-Chloroaniline	106-47-8		170		120
Hexachlorobutadiene	87-68-3		170		120
Caprolactam	105-60-2		170		120
4-Chloro-3-methylphenol	59-50-7		170		120
2-methyl naphthalene	91-57-6		170		120
Hexachlorocyclopentadiene	77-47-4		170		120
1,2,4,5-Tetrachlorobenzene	95-94-3		170		120
2,4,6-Trichlorophenol	88-06-2		170		120
2,4,5-Trichlorophenol	95-95-4		170		120
1,1'-Biphenyl	92-52-4		170		120
2-Chloronaphthalene	91-58-7		170		120
2-Nitroaniline	88-74-4		330		120
Dimethyl phthalate	131-11-3		170		120
Acenaphthylene	208-96-8		170		120
2,6-Dinitrotoluene	606-20-2		170		120

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs ⁵ µg/kg	Achievable (DESA) Limits ²	
				MDLs µg/kg	RLs µg/kg
3-Nitroaniline	99-09-2		330		120
Acenaphthene	83-32-9		170		120
2,4-Dinitrophenol	51-28-5		330		800
4-Nitrophenol	100-02-7		330		400
Dibenzofuran	132-64-9		170		120
2,4-Dinitrotoluene	121-14-2		170		120
2,3,4,6-Tetrachlorophenol	58-90-2		170		120
Fluorene	86-73-7		170		120
Diethylphthalate	84-66-2		170		120
4-Chlorophenyl phenyl ether	7005-72-3		170		120
4-Nitroaniline	100-01-6		330		120
4,6-Dinitro-2-Methylphenol	534-52-1		330		400
N-Nitrosodiphenylamine	86-30-6		170		120
4-Bromophenyl phenyl ether	101-55-3		170		120
Hexachlorobenzene	118-74-1		170		120
Atrazine	1912-24-9		170		120
Pentachlorophenol	87-86-5		330		400
Phenanthrene	85-01-8		170		120
Anthracene	120-12-7		170		120
Carbazole	86-74-8		170		120
Di-n-butyl phthalate	84-74-2		170		120
Fluoranthene	206-44-0		170		120
Pyrene	129-00-0		170		120
Butylbenzylphthalate	85-68-7		170		120
3,3-Dichlorobenzidine	91-94-1		170		120
Benzo(a)anthracene	56-55-3		170		120
Chrysene	218-01-9		170		120
Bis(2-ethylhexyl)phthalate	117-81-7		170		120
Di-n-octyl phthalate	117-84-0		170		120
Benzo(b)Fluoranthene	205-99-2		170		120
Benzo(k)Fluoranthene	207-08-9		170		120
Benzo(a)pyrene	50-32-8		170		120
Indeno(1,2,3-cd)pyrene	193-39-5		170		120
Dibenzo(a,h)anthracene	53-70-6-3		170		120
Benzo(g,h,i)perylene	191-24-2		170		120
1,4-Dioxane					

Note: Based on the new CRQLs the MDL study is currently being reanalyzed.

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Semi -Volatile Organic Compounds
Concentration Level: Low

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs	Achievable (DESA) Limits	
				MDLs µg/L	RLs
Benzaldehyde	100-52-7		5 µg/L	0.10	5 µg/L
Phenol	108-95-2		5 µg/L	1.36	5 µg/L
Bis(2-Chloroethyl)ether	111-44-4		5 µg/L	1.38	5 µg/L
2-Chlorophenol	95-57-8		5 µg/L	1.43	5 µg/L
2-Methylphenol	95-48-7		5 µg/L	0.99	5 µg/L
Bis(2-Chloroisopropyl)ether	108-60-1		5 µg/L	1.23	5 µg/L
Acetophenone	98-86-2		5 µg/L	0.9	5 µg/L
4-Methylphenol	106-44-5		5 µg/L	0.81	5 µg/L
N-Nitroso-di-n-propylamine	621-64-7		5 µg/L	0.99	5 µg/L
Hexachloroethane	67-72-1		5 µg/L	1.35	5 µg/L
Nitrobenzene	98-95-3		5 µg/L	1.13	5 µg/L
Isophorone	78-59-1		5 µg/L	0.76	5 µg/L
2-Nitrophenol	88-75-5		5 µg/L	1.08	5 µg/L
2,4-Dimethylphenol	105-67-9		5 µg/L	1.81	5 µg/L
Bis(2-Chloroethoxy)methane	111-91-1		5 µg/L	0.97	5 µg/L
2,4-Dichlorophenol	120-83-2		5 µg/L	0.94	5 µg/L
Naphthalene	91-20-3		5 µg/L	1.05	5 µg/L
4-Chloroaniline	106-47-8		5 µg/L	0.42	5 µg/L
Hexachlorobutadiene	87-68-3		5 µg/L	1.02	5 µg/L
Caprolactam	105-60-2		5 µg/L	1.0	5 µg/L
4-Chloro-3-methylphenol	59-50-7		5 µg/L	0.62	5 µg/L
2-Methyl naphthalene	91-57-6		5 µg/L	0.88	5 µg/L
Hexachlorocyclopentadiene	77-47-4		5 µg/L	0.92	5 µg/L
1,2,4,5-Tetrachlorobenzene	95-94-3		5 µg/L	0.8	5 µg/L
2,4,6-Trichlorophenol	88-06-2		5 µg/L	0.55	5 µg/L
2,4,5-Trichlorophenol	95-95-4		5 µg/L	0.76	5 µg/L
1,1'-Biphenyl	92-52-4		5 µg/L	1.0	5 µg/L
2-Chloronaphthalene	91-58-7		5 µg/L	0.80	5 µg/L
2-Nitroaniline	88-74-4		10 µg/L	0.70	5 µg/L
Dimethyl phthalate	131-11-3		5 µg/L	0.47	5 µg/L
Acenaphthylene	208-96-8		10 µg/L	0.77	5 µg/L
2,6-Dinitrotoluene	606-20-2		5 µg/L	0.79	5 µg/L
3-Nitroaniline	99-09-2		10 µg/L	0.76	5 µg/L

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs	Achievable (DESA) Limits	
				MDLs µg/L	RLs
Acenaphthene	83-32-9		5 µg/L	0.72	5 µg/L
2,4-Dinitrophenol	51-28-5		10 µg/L	0.33	20µg/L
4-Nitrophenol	100-02-7		10 µg/L	0.35	10µg/L
Dibenzofuran	132-64-9		5 µg/L	0.72	5 µg/L
2,4-Dinitrotoluene	121-14-2		5 µg/L	0.48	5 µg/L
2,3,4,6-Tetrachlorophenol	58-90-2		5 µg/L		5 µg/L
Fluorene	86-73-7		5 µg/L	0.61	5 µg/L
Diethylphthalate	84-66-2		5 µg/L	0.39	5 µg/L
4-Chlorophenyl Phenyl Ether	7005-72-3		5 µg/L	0.57	5 µg/L
4-Nitroaniline	100-01-6		10 µg/L	0.34	5 µg/L
4,6-Dinitro-2-Methylphenol	534-52-1		10 µg/L	0.85	10µg/L
N-Nitrosodiphenylamine	86-30-6		5 µg/L	0.61	5 µg/L
4-Bromophenyl Phenyl Ether	101-55-3		5 µg/L	0.58	5 µg/L
Hexachlorobenzene	118-74-1		5 µg/L	0.49	5 µg/L
Atrazine	1912-24-9		5 µg/L	1.5	5 µg/L
Pentachlorophenol	87-86-5		10 µg/L	0.91	10µg/L
Phenanthrene	85-01-8		5 µg/L	0.47	5 µg/L
Anthracene	120-12-7		5 µg/L	0.58	5 µg/L
Carbazole	86-74-8		5 µg/L	1.2	5 µg/L
Di-N-Butyl Phthalate	84-74-2		5 µg/L	0.48	5 µg/L
Fluoranthene	206-44-0		5 µg/L	0.51	5 µg/L
Pyrene	129-00-0		5 µg/L	0.53	5 µg/L
Butylbenzylphthalate	85-68-7		5 µg/L	0.49	5 µg/L
3,3-Dichlorobenzidine	91-94-1		5 µg/L	0.4	5 µg/L
Benzo(a)anthracene	56-55-3		5 µg/L	0.58	5 µg/L
Chrysene	218-01-9		5 µg/L	0.53	5 µg/L
Bis(2-Ethylhexyl)phthalate	117-81-7		5 µg/L	0.68	5 µg/L
Di-n-octyl phthalate	117-84-0		5 µg/L	0.57	5 µg/L
Benzo(b)fluoranthene	205-99-2		5 µg/L	0.41	5 µg/L
Benzo(k)fluoranthene	207-08-9		5 µg/L	0.60	5 µg/L
Benzo(a)pyrene	50-32-8		5 µg/L	0.55	5 µg/L
Indeno(1,2,3-cd)pyrene	193-39-5		5 µg/L	0.50	5 µg/L
Dibenzo(a,h)anthracene	53-70-6-3		5 µg/L	0.42	5 µg/L
Benzo(g,h,i)perylene	191-24-2		5 µg/L	0.35	5 µg/L
*1,4-Dioxane					2 µg/L

MDL study is being performed

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Volatile Organic Compounds
Concentration Level: Low

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs µg/kg	Achievable (DESA) Limits ²	
				MDLs µg/kg	RLs µg/kg
Dichlorodifluoromethane	75-71-8		5	0.7	5
Chloromethane	74-87-3		5	2.2	5
Vinyl Chloride	75-01-4		5	*	5
Bromomethane	74-83-9		5	1.3	5
Chloroethane	75-00-3		5	0.9	5
Trichlorofluoromethane	75-69-4		5	0.4	5
1,1-Dichloroethene	75-35-4		5	0.7	5
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		5	0.8	5
Carbon Disulfide	75-15-0		5	0.8	5
Acetone	67-64-1		10	4.0	10
Methyl Acetate	79-20-9		5	1.6	5
Methylene Chloride	75-09-2		5	0.6	5
trans-1,2-Dichloroethene	156-60-5		5	0.5	5
cis-1,2-Dichloroethene	156-59-2		5	0.6	5
Methyl tert-Butyl Ether	1634-04-4		5	0.3	5
1,1-Dichloroethane	75-34-3		5	0.7	5
2-Butanone	78-93-3		10	1.2	10
Chloroform	67-66-3		5	0.3	5
1,2-Dichloroethane	107-06-2		5	0.5	5
1,1,1-Trichloroethane	71-55-6		5	0.3	5
Cyclohexane	110-82-7		5	0.4	5
Carbon Tetrachloride	56-23-5		5	1.9	5
Benzene	71-43-2		5	0.5	5
Trichloroethene	79-01-6		5	0.6	5
Methylcyclohexane	108-87-2		5	0.8	5
1,2-Dichloropropane	78-87-5		5	0.5	5
Bromodichloromethane	75-27-4		5	0.5	5
cis-1,3-Dichloropropene	10061-01-5		5	0.6	5
trans-1,3-Dichloropropene	10061-02-6		5	0.6	5
1,1,2-Trichloroethane	79-00-5		5	0.3	5
Dibromochloromethane	124-48-1		5	0.5	5
4-Methyl-2-Pentanone	108-10-1		10	0.6	10
Toluene	108-88-3		5	1.2	5

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs µg/kg	Achievable (DESA) Limits ²	
				MDLs µg/kg	RLs µg/kg
1,2-Dibromoethane	106-93-4		5	0.4	5
Chlorobenzene	108-90-7		5	0.8	5
Tetrachloroethene	127-18-4		5	0.5	5
2-Hexanone	591-78-6		10	0.5	10
Ethylbenzene	100-41-4		5	0.6	5
m,p-Xylene	179601-23-1		5	1.1	5
o-Xylene	95-47-6		5	0.7	5
Styrene	100-42-5		5	0.7	5
Bromoform	75-25-2		5	0.6	5
Isopropylbenzene	98-82-8		5	0.6	5
1,1,2,2-Tetrachloroethane	79-34-5		5	0.4	5
1,3-Dichlorobenzene	541-73-1		5	1.1	5
1,4-Dichlorobenzene	106-46-7		5	1.2	5
1,2-Dichlorobenzene	95-50-1		5	1.0	5
1,2-Dibromo-3-Chloropropane	96-12-8		5	0.5	5
1,2,4-Trichlorobenzene	120-82-1		5	1.5	5
1,2,3-Trichlorobenzene	87-61-6		5	1.5	5
Bromochloromethane	74-97-5		5	0.6	5

* MDL Study will be performed

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Volatile Organic Compounds
Concentration Level: Medium

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQL µg/kg	Achievable (DESA) Limits ²	
				MDLs µg/kg	RLs µg/kg
Dichlorodifluoromethane	75-71-8		250		250
Chloromethane	74-87-3		250		250
Vinyl Chloride	75-01-4		250		250
Bromomethane	74-83-9		250		250
Chloroethane	75-00-3		250		250
Trichlorofluoromethane	75-69-4		250		250
1,1-Dichloroethene	75-35-4		250		250
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		250		250
Carbon Disulfide	75-15-0		250		250
Acetone	67-64-1		500		500
Methyl Acetate	79-20-9		250		250
Methylene Chloride	75-09-2		250		250
trans-1,2-Dichloroethene	156-60-5		250		250
cis-1,2-Dichloroethene	156-59-2		250		250
Methyl tert-butyl ether	1634-04-4		250		250
1,1-Dichloroethane	75-34-3		250		250
2-Butanone	78-93-3		500		500
Chloroform	67-66-3		250		250
1,2-Dichloroethane	107-06-2		250		250
1,1,1-Trichloroethane	71-55-6		250		250
Cyclohexane	110-82-7		250		250
Carbon Tetrachloride	56-23-5		250		250
Benzene	71-43-2		250		250
Trichloroethene	79-01-6		250		250
Methylcyclohexane	108-87-2		250		250
1,2-Dichloropropane	78-87-5		250		250
Bromodichloromethane	75-27-4		250		250
cis-1,3-Dichloropropene	10061-01-5		250		250
trans-1,3-Dichloropropene	10061-02-6		250		250
1,1,2-Trichloroethane	79-00-5		250		250
Dibromochloromethane	124-48-1		250		250
4-Methyl-2-pentanone	108-10-1		500		500
Toluene	108-88-3		250		250

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQL µg/kg	Achievable (DESA) Limits ²	
				MDLs µg/kg	RLs µg/kg
1,2-Dibromoethane	106-93-4		250		250
Chlorobenzene	108-90-7		250		250
Tetrachloroethene	127-18-4		250		250
2-Hexanone	591-78-6		500		500
Ethylbenzene	100-41-4		250		250
m,p-Xylene	179601-23-1		250		250
o-Xylene	95-47-6		250		250
Styrene	100-42-5		250		250
Bromoform	75-25-2		250		250
Isopropylbenzene	98-82-8		250		250
1,1,2,2-Tetrachloroethane	79-34-5		250		250
1,3-Dichlorobenzene	541-73-1		250		250
1,4-Dichlorobenzene	106-46-7		250		250
1,2-Dichlorobenzene	95-50-1		250		250
1,2-Dibromo-3-Chloropropane	96-12-8		250		250
1,2,4-Trichlorobenzene	120-82-1		250		250
1,2,3-Trichlorobenzene	87-61-6		250		250
Bromochloromethane	74-97-5		250		250

Note: Based on the new CRQLs the MDL study is currently being reanalyzed.

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Volatile Organic Compounds
Concentration Level: Low

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs	Achievable (DESA) Limit	
				MDLs	µg/L RLs
Dichlorodifluoromethane	75-71-8		5 µg/L	0.3	5 µg/L
Chloromethane	74-87-3		5 µg/L	0.54	5 µg/L
Vinyl Chloride	75-01-4		5 µg/L	1.52	5 µg/L
Bromomethane	74-83-9		5 µg/L	1.90	5 µg/L
Chloroethane	75-00-3		5 µg/L	1.01	5 µg/L
Trichlorofluoromethane	75-69-4		5 µg/L	2.18	5 µg/L
1,1-Dichloroethene	75-35-4		5 µg/L	1.12	5 µg/L
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		5 µg/L	0.3	5 µg/L
Carbon Disulfide	75-15-0		5 µg/L	1.58	5 µg/L
Acetone	67-64-1		10 µg/L	0.67	10 µg/L
Methyl Acetate	79-20-9		5 µg/L	0.4	5 µg/L
Methylene Chloride	75-09-2		5 µg/L	0.52	5 µg/L
trans-1,2-Dichloroethene	156-60-5		5 µg/L	0.91	5 µg/L
cis-1,2-Dichloroethene	156-59-2		5 µg/L	0.2	5 µg/L
Methyl tert-Butyl Ether	1634-04-4		5 µg/L	0.4	5 µg/L
1,1-Dichloroethane	75-34-3		5 µg/L	0.58	5 µg/L
2-Butanone	78-93-3		10 µg/L	0.7	10 µg/L
Chloroform	67-66-3		5 µg/L	0.44	5 µg/L
1,2-Dichloroethane	107-06-2		5 µg/L	0.55	5 µg/L
1,1,1-Trichloroethane	71-55-6		5 µg/L	0.6	5 µg/L
Cyclohexane	110-82-7		5 µg/L	0.6	5 µg/L
Carbon Tetrachloride	56-23-5		5 µg/L	1.23	5 µg/L
Benzene	71-43-2		5 µg/L	0.46	5 µg/L
Trichloroethene	79-01-6		5 µg/L	0.99	5 µg/L
Methylcyclohexane	108-87-2		5 µg/L	0.7	5 µg/L
1,2-Dichloropropane	78-87-5		5 µg/L	0.44	5 µg/L
Bromodichloromethane	75-27-4		5 µg/L	0.51	5 µg/L
cis-1,3-Dichloropropene	10061-01-5		5 µg/L	0.63	5 µg/L
trans-1,3-Dichloropropene	10061-02-6		5 µg/L	0.4	5 µg/L
1,1,2-Trichloroethane	79-00-5		5 µg/L	0.3	5 µg/L
Dibromochloromethane	124-48-1		5 µg/L	0.2	5 µg/L
4-Methyl-2-Pentanone	108-10-1		10 µg/L	0.64	10 µg/L
Toluene	108-88-3		5 µg/L	0.77	5 µg/L

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method QLs	Achievable (DESA) Limit	
				MDLs	µg/L RLs
1,2-Dibromoethane	106-93-4		5 µg/L	0.2	5 µg/L
Chlorobenzene	108-90-7		5 µg/L	0.59	5 µg/L
Tetrachloroethene	127-18-4		5 µg/L	1.11	5 µg/L
2-Hexanone	591-78-6		10 µg/L	0.68	10 µg/L
Ethylbenzene	100-41-4		5 µg/L	0.59	5 µg/L
m,p-Xylene	179601-23-1		5 µg/L	1.17	5 µg/L
o-Xylene	95-47-6		5 µg/L	0.56	5 µg/L
Styrene	100-42-5		5 µg/L	0.57	5 µg/L
Bromoform	75-25-2		5 µg/L	0.43	5 µg/L
Isopropylbenzene	98-82-8		5 µg/L	0.3	5 µg/L
1,1,2,2-Tetrachloroethane	79-34-5		5 µg/L	0.64	5 µg/L
1,3-Dichlorobenzene	541-73-1		5 µg/L	0.82	5 µg/L
1,4-Dichlorobenzene	106-46-7		5 µg/L	0.84	5 µg/L
1,2-Dichlorobenzene	95-50-1		5 µg/L	0.75	5 µg/L
1,2-Dibromo-3-Chloropropane	96-12-8		5 µg/L	0.7	5 µg/L
1,2,4-Trichlorobenzene	120-82-1		5 µg/L	0.4	5 µg/L
*1,2,3-Trichlorobenzene	87-61-6		5 µg/L		5 µg/L
* Bromochloromethane	74-97-5		5 µg/L		5 µg/L

* MDL study will be performed.

QAPP Worksheet #15
Reference Limits and Evaluation Table

Matrix: Aqueous
Analytical Group: Volatile Organic Compounds
Concentration Level: Trace

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQLs	Achievable (DESA) Limits ²	
				MDLs µg/L	RLs
Dichlorodifluoromethane	75-71-8		0.5 µg/L	0.11	0.5 µg/L
Chloromethane	74-87-3		0.5 µg/L	0.07	0.5 µg/L
Vinyl Chloride	75-01-4		0.5 µg/L	0.12	0.5 µg/L
Bromomethane	74-83-9		0.5 µg/L	0.14	0.5 µg/L
Chloroethane	75-00-3		0.5 µg/L	0.14	0.5 µg/L
Trichlorofluoromethane	75-69-4		0.5 µg/L	0.11	0.5 µg/L
1,1-Dichloroethene	75-35-4		0.5 µg/L	0.10	0.5 µg/L
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		0.5 µg/L		0.5 µg/L
Carbon Disulfide	75-15-0		0.5 µg/L	0.10	0.5 µg/L
Acetone	67-64-1		5.0µg/L	0.36	0.5 µg/L
Methyl Acetate	79-20-9		0.5 µg/L		0.5 µg/L
Methylene Chloride	75-09-2		0.5 µg/L	0.18	0.5 µg/L
trans-1,2-Dichloroethene	156-60-5		0.5 µg/L	0.09	0.5 µg/L
cis-1,2-Dichloroethene	156-59-2		0.5 µg/L	0.06	0.5 µg/L
Methyl tert-butyl ether	1634-04-4		0.5 µg/L	0.03	0.5 µg/L
1,1-Dichloroethane	75-34-3		0.5 µg/L	0.08	0.5 µg/L
2-Butanone	78-93-3		5.0µg/L	0.21	0.5 µg/L
Chloroform	67-66-3		0.5 µg/L	0.07	0.5 µg/L
1,2-Dichloroethane	107-06-2		0.5 µg/L	0.09	0.5 µg/L
1,1,1-Trichloroethane	71-55-6		0.5 µg/L	0.09	0.5 µg/L
Cyclohexane	110-82-7		0.5 µg/L		0.5 µg/L
Carbon Tetrachloride	56-23-5		0.5 µg/L	0.10	0.5 µg/L
Benzene	71-43-2		0.5 µg/L	0.07	0.5 µg/L
Trichloroethene	79-01-6		0.5 µg/L	0.08	0.5 µg/L
Methylcyclohexane	108-87-2		0.5 µg/L		0.5 µg/L
1,2-Dichloropropane	78-87-5		0.5 µg/L	0.04	0.5 µg/L
Bromodichloromethane	75-27-4		0.5 µg/L	0.06	0.5 µg/L
cis-1,3-Dichloropropene	10061-01-5		0.5 µg/L	0.05	0.5 µg/L
trans-1,3-Dichloropropene	10061-02-6		0.5 µg/L	0.04	0.5 µg/L
1,1,2-Trichloroethane	79-00-5		0.5 µg/L	0.08	0.5 µg/L
Dibromochloromethane	124-48-1		0.5 µg/L	0.03	0.5 µg/L
4-Methyl-2-pentanone	108-10-1		0.5 µg/L	0.10	0.5 µg/L
Toluene	108-88-3		0.5 µg/L	0.08	0.5 µg/L

Analyte	CAS Number	Project (PRP) Quantitation Limit ³	Method CRQLs	Achievable (DESA) Limits ²	
				MDLs µg/L	RLs
1,2-Dibromoethane	106-93-4		0.5 µg/L	0.04	0.5 µg/L
Chlorobenzene	108-90-7		0.5 µg/L	0.06	0.5 µg/L
Tetrachloroethene	127-18-4		0.5 µg/L	0.09	0.5 µg/L
2-Hexanone	591-78-6		5.0µg/L	0.11	0.5 µg/L
Ethylbenzene	100-41-4		0.5 µg/L	0.06	0.5 µg/L
m,p-Xylene	179601-23-1		0.5 µg/L	0.13	0.5 µg/L
o-Xylene	95-47-6		0.5 µg/L	0.05	0.5 µg/L
Styrene	100-42-5		0.5 µg/L	0.03	0.5 µg/L
Bromoform	75-25-2		0.5 µg/L	0.07	0.5 µg/L
Isopropylbenzene	98-82-8		0.5 µg/L	0.06	0.5 µg/L
1,1,2,2-Tetrachloroethane	79-34-5		0.5 µg/L	0.05	0.5 µg/L
1,3-Dichlorobenzene	541-73-1		0.5 µg/L	0.05	0.5 µg/L
1,4-Dichlorobenzene	106-46-7		0.5 µg/L	0.03	0.5 µg/L
1,2-Dichlorobenzene	95-50-1		0.5 µg/L	0.04	0.5 µg/L
1,2-Dibromo-3-Chloropropane	96-12-8		0.5 µg/L	0.18	0.5 µg/L
1,2,4-Trichlorobenzene	120-82-1		0.5 µg/L	0.06	0.5 µg/L
1,2,3-Trichlorobenzene	87-61-6		0.5 µg/L	0.05	0.5 µg/L
Bromochloromethane	74-97-5		0.5 µg/L	0.10	0.5 µg/L

QAPP Worksheet #19

(UFP-QAPP Manual Section 3.1.1)

For each matrix, analytical group, and concentration level, list the analytical and preparation method/SOP and associated sample volume, container specifications, preservation requirements, and maximum holding time.

Title:**Revision Number:****Revision Date:****Page ____ of ____****Analytical SOP Requirements Table**

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference¹	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Aqueous	TCL Volatiles	Low Medium	DW-1 (Ref: EPA 524.2) C-89 (Ref: EPA 624)	3 X40ml 6 X 40ml (QC)	VOA vial with Teflon-lined septum	Cool, 4°C ; HCL to pH < 2 Na ₂ S ₂ O ₃ , if Res CL present	Preserved w/HCL: 14 days: Unpreserved: 7 days
Soil	TCL Volatiles	Low- Medium	C-123 (Ref: SOM01.1)	1 x 100g or 4 X Encore Same(QC)	Glass, wide mouth or Encore samplers	Cool, 4°C or Frozen (-10 to - 14)	14 days
Aqueous	TCL Semi-Volatiles	Low	C-90 (Ref: EPA 625)	2 X 1000ml 2 X1000 ml(QC)	Amber Glass	Cool, 4°C ; Na ₂ S ₂ O ₃ , if Res CL present	To extraction: 7 days;40 days to analysis
Soil	TCL Semi-Volatiles	Low	C-90 (Ref: EPA 625)	1 x 250g 1 x 250g(QC)	Glass, wide mouth	Cool, 4°C	To extraction: 14 days;40 days to analysis
Aqueous	Pesticides/PCBs	Low	C-91 (Ref: EPA 608)	2 X 1000ml 2 X1000 ml(QC)	Amber Glass	Cool, 4°C	To extraction: 7 days;40 days to analysis
Soil	Pesticides/PCBs	Low	C-91 (Ref: EPA 608)	1 x 100g 1 x 100g(QC)	Glass, wide mouth	Cool, 4°C	To extraction: 14 days;40 days to analysis

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference¹	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Aqueous	TAL Metals/Mercury	Low	C-109, C-116 (Ref: EPA 200.7) C- 110, C-112 (Ref: EPA 245.1)	1 X 500ml 1 X 250ml(QC)	Rigid Plastic	HNO3 to pH <2	6 months Hg- 28days
Soil	TAL Metals/Mercury	Low	C-109, C-116 (Ref: EPA 200.7) C- 110, C-112 (Ref: EPA 245.1)	1 X 250ml 1 X 250ml(QC)	Rigid Plastic	HNO3 to pH <2	6 months Hg- 28days
Soil	TCLP Metals/Mercury	Low	C-107, C-109, C-116 (Ref: EPA 200.7) C-107, C- 110, C-112 (Ref: EPA 245.1)	1 X 1000ml 1 X 1000ml(QC)	Rigid/Glass, wide mouth	Cool, 4°C	To extraction: 6 months Hg- 28days;6 months Hg- 28days to analysis
Soil	TCLP - Volatiles	Low-medium	C-106, C-89 (Ref: EPA 624)	2 X 100g or 1 x 100g And 2 x Encore Same (QC)	Glass, wide mouth and/ or Encore samplers	Cool, 4°C or Frozen (-10 to -14)	To extraction: 14 days; 14 days to analysis
Soil	TCLP – Semi-Volatiles	Low	C-107, C-90 (Ref: EPA 625)	1 X 1000g 1 x 1000g (QC)	Amber Glass	Cool, 4°C	To (TCLP_extraction): 14 days; 7 days after (TCLP_extraction); 40 days after 2 nd extraction.
Soil	TCLP – Pesticides	Low	C-107, C-91 (Ref: EPA 608)	1 X 250g 1 x 250g (QC)	Glass, wide mouth	Cool, 4°C	To (TCLP_extraction): 14 days; 7 days after (TCLP_extraction); 40 days after 2 nd extraction.
Soil	Cyanide	Low	C-28 (Ref: EPA 335.4)	1 X 20g 1 X 50g (QC)	Rigid/Glass, wide mouth	Cool, 4°C	14 days
Soil	TOC	N/A	C-88 (Ref: SM 5310 B)	1 x 50g 1 X 50g (QC)	Glass, wide mouth	Cool, 4°C	28 days
Soil	pH	N/A	C-24 (Ref: EPA 4500-H+ B)	1 X 100g 1 X 250g(QC)	Rigid Plastic, widemouth	Cool, 4°C	As soon as possible

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference¹	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Aqueous	BOD	N/A	C-21 (Ref: SM 5210 B)	1 X 2000 ml or 2 X 1000ml (QC)	Rigid Plastic	Cool, 4°C ;	48 hours
Aqueous	Ammonia	N/A	C-80 (Ref: EPA 350.1)	1 X 250 ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C ; H ₂ SO ₄ to pH < 2	28 days
Aqueous	Chloride	N/A	C-22 (Ref: EPA 405.1) C-94 (Ref: EPA 300)	1 X 50 ml 1 X 100ml (QC)	Rigid Plastic	None	28 days
Aqueous	COD	N/A	C-53 (Ref: EPA 410.4)	1 X 50 ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C ; H ₂ SO ₄ to pH < 2	28 days
Aqueous	Fluoride	N/A	C-93 (Ref: USGS-I-4327-85) C-94 (Ref: EPA 300)	1 X 50 ml 1 X 100ml (QC)	Rigid Plastic	None	28 days
Aqueous	Nitrite	N/A	C-79 (Ref: EPA 353.2) C-94 (Ref: EPA 300)	1 X 50 ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C	48 hours
Aqueous	Nitrate	N/A	C-79 (Ref: EPA 353.2) C-94 (Ref: EPA 300)	1 X 50 ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C	48 hours
Aqueous	Nitrite+ Nitrate	N/A	C-79 (Ref: EPA 353.2) C-94 (Ref: EPA 300)	1 X 50 ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C	28 days
Aqueous-Grab	Oil +Grease	N/A	C-95 (Ref: EPA 1664A)	1 X 1000 ml 3 X 1000ml (QC)	Glass	Cool, 4°C ; H ₂ SO ₄ to pH < 2	28 days

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference¹	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Aqueous-Grab	Total Petroleum Hydrocarbon	N/A	C-95 (Ref: EPA 1664A)	1 X 1000 ml 3 X 1000ml (QC)	Glass	Cool, 4°C ; H ₂ SO ₄ to pH < 2	28 days
Soil	Total Petroleum Hydrocarbon	N/A	C-95 (Ref: EPA 1664A)	250g 250g (QC)	Glass, wide mouth	Cool, 4°C	28 days
Aqueous	Total Phenols	N/A	C-29 (Ref: EPA 420.4)	1 X 250ml 1 X 250ml (QC)	Glass	Cool, 4°C ; H ₂ SO ₄ to pH < 2	28 days
Aqueous	Sulfate	N/A	C-19 (Ref: ASTM D516-02) C-94 (Ref: EPA 300.0)	1 X 100ml 1 X 50ml (QC)	Rigid Plastic	Cool, 4°C	28 days
Aqueous	Sulfide	N/A	C-115 (Ref: SM 4500-S ² D)	1 X 100ml 1 X 250ml (QC)	Rigid Plastic	Cool, 4°C ; ZnAcetate +NaOH pH > 9	7 days
Aqueous	Total Phosphorus	N/A	C-68 (Ref: EPA 365.1)	1 X 50ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C ; H ₂ SO ₄ to pH < 2	28 days
Aqueous	TKN	N/A	C-40 (Ref: EPA 351.2)	1 X 50ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C ; H ₂ SO ₄ to pH < 2	28 days

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference¹	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Aqueous	Turbidity	N/A	C-81 (Ref: EPA 351.2)	1 X 100ml 1 X 250ml (QC)	Rigid Plastic	Cool, 4°C	48 hours
Aqueous	Total Suspended Solids(TSS)/Volatile Suspended Solids(VSS)	N/A	C-33 (Ref: SM 2540 D)	1 X 250ml 1 X 500ml (QC)	Rigid Plastic	Cool, 4°C	7 days
Aqueous	Total Dissolved Solids (TDS)	N/A	C-37 (Ref: SM 2540 C)	1 X 250ml 1 X 500ml (QC)	Rigid Plastic	Cool, 4°C	7 days
Aqueous	Total Organic Carbon (TOC)	N/A	C-83 (Ref: SM 5310 B)	1 X 50ml 1 X 100ml (QC)	Rigid Plastic	Cool, 4°C	28 days
NAPL	Ignitability	N/A	C-23 (Ref: SW846 Method 1010)	1 X 250ml 1 X 250ml (QC)	Glass, wide mouth or Metal Can	None	None
Aqueous	Specific Conductance	N/A	C-36 (Ref: EPA 120.1)	1 X 100ml 1 X 250ml (QC)	Rigid Plastic	Cool, 4°C	28 days
Aqueous	Hexavalent Chromium	N/A	C-96 (Ref: USGS-I-1230-85)	1 X 250ml 1 X 500ml (QC)	Rigid Plastic	Cool, 4°C/ Cool, 4°C pH= 9.3-9.7 Ammonium Sulfate Buffer solution	24 hours/ 28 days

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/SOP Reference ¹	Sample Volume	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Aqueous	Alkalinity	N/A	C-18 (Ref: SM 2320 B)	1 X 100ml 1 X 250ml (QC)	Rigid Plastic	Cool, 4°C	14 days
Aqueous	Total Coliform/ Fecal Coliform	N/A	B-6/B-8 (Ref: SM 9221B/9221E)	1 X 150ml 1 X 150ml (QC)	Rigid Plastic, wide mouth	Cool, 4°C ; Na ₂ S ₂ O ₃ , if Res CL present	6 hours
Sewage Sludge	Total Coliform /Fecal Coliform	N/A	B-6/B-8 (Ref: SM 9221B/9221E) B-5/B-7 (Ref: SM 9222B/9222E) Colilert-18 (Ref: SM9223B)	1 X 250g 1 X 250g (QC)	Rigid Plastic, wide mouth	Cool, 4°C	24 hours
Aqueous	Heterotrophic Plate Count	N/A	B-32 (Ref: EPA 9215B) B-38 (Ref: Simplate IDEX)	1X125 ml	Rigid Plastic, wide mouth	Cool, 4°C ; Na ₂ S ₂ O ₃ , if Res CL present	8 hours
Soil/Sediment	Grain (Particle) Size	N/A	Bio 8.3 Ref: ASTM D422-63)	1 X 16oz/500g/500ml 1 X 16oz/500g/500ml (QC)	Rigid Plastic/ Glass wide mouth	Cool, 4°C	None

¹Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

QAPP Worksheet #23
(UFP-QAPP Manual Section 3.2.1)

Title:
Revision Number:

Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
Bio 8.3	Grain (Particle)Size, Rev 2.0, 3/07	Definite	Grain (Particle)Size	Soil Hydrometer	DESA	N
B-5/B-7	Total Coliform/ Fecal Coliform, Rev 2.0, 2/07	Definite	Total Coliform/ Fecal Coliform	N/A	DESA	N
B-6/B-8	Total Coliform/ Fecal Coliform, Rev 2.0, 2/07	Definite	Total Coliform/ Fecal Coliform	N/A	DESA	N
C-18	Alkalinity, , Rev 2.0, 3/07	Definite	Alkalinity	Auto Titrator System	DESA	N
C-19, C-94	Sulfate, Rev 2.0, 3//07, Anions by Ion Chromatography, Rev 2.0, 3/07	Definite	Sulfate	Spectrophotometer, AutoAnalyzer, IC	DESA	N
C-21	BOD/CBOD, Rev 2.0, 3/07	Definite	BOD	DO meter	DESA	N
C-22, C-94	Chloride, Rev 2.0, 3//07, Anions by Ion Chromatography, Rev 2.0, 3/07	Definite	Chloride	Titration unit, AutoAnalyzer,, IC	DESA	N
C-23	Ignitability, Rev 1.0, 1/06	Definite	Ignitability	Auto flash Point Test Instrument	DESA	N
C-24	pH, Rev 2.0, 3/07	Definite	pH	pH meter	DESA	N
C-28	Cyanides, Total, Rev 2.0, 3/07	Definite	Cyanide	AutoAnalyzer	DESA	N

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
C-29	Total Phenols, Rev 2.0, 3/07	Definite	Total Phenols	AutoAnalyzer	DESA	N
C-33	Total Suspended Solids(TSS)/Volatile Suspended Solids(VSS), Rev 2.0, 2/07	Definite	Total Dissolved Solids (TDS)	N/A	DESA	N
C-36	Specific Conductance, Rev 2.0, 3/07	Definite	Specific Conductance	Conductivity Meter	DESA	N
C-37	Total Dissolved Solids (TDS) , Rev 2.0, 2/07	Definite	Total Dissolved Solids (TDS)	N/A	DESA	N
C-40	TKN, Rev 2.0, 2/07	Definite	TKN	AutoAnalyzer	DESA	N
C-53	COD, Rev 2.0, 3/07	Definite	COD	COD Reactor, Spectrophotometer	DESA	N
C-68	Total Phosphorus, Rev 2.0, 12/06	Definite	Total Phosphorus	AutoAnalyzer	DESA	N
C-79, C-94	Nitrite, Nitrate, Nitrite+ Nitrate Rev 2.0, 2//07, Anions by Ion Chromatography, Rev 2.0, 12/06	Definite	Nitrite	AutoAnalyzer, IC	DESA	N
C-80	Ammonia, Rev 2.0, 12/06	Definite	Ammonia	AutoAnalyzer	DESA	N
C-81	Turbidity, Rev 2.0, 3/07	Definite	Turbidity	Turbidimeter	DESA	N

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
C-83	Total Organics in Aqueous, Rev 2.0, 3/07	Definite	Total Organics Carbon	TOC analyzer	DESA	N
C-88	Total Organics in Soil, Rev 1.0, 1/05	Definite	Total Organics Carbon	TOC analyzer	DESA	N
C-89	Analysis of Volatile Organic Compounds in Aqueous, Soil/Sediment and Waste Oil/Waste Organic Solvents Samples by Purge and Trap GC/MS, Rev 2.0, 3/07	Definite	TCL Volatiles(Aqueous)	GC-MS	DESA L	N
C-123	Analysis of Volatile Organic Compounds by Automated Closed System by Purge and Trap GC/MS, Rev 2.0, 3/07	Definite	TCL Volatiles(Low Soil)	GC-MS	DESA Laboratory	N
DW-1	Volatile Organics in Drinking Water by Purge and Trap by GC/MS, Rev 2.0, 3/07	Definite	TCL Volatiles (Trace)	GC-MS	DESA Laboratory	N
C-90	Analysis of Base/Neutral and Acid Compounds in Aqueous, Soil/Sediment and Waste Oil/Waste Organic Solvent Samples, Rev 2.0, 3/07	Definite	TCL Semi-Volatiles	GC-MS	DESA Laboratory	N
C-91	Analysis of Pesticides and PCBs in Aqueous, Soil/Sediments and Waste Oil/Transformer Fluid Matrices, Rev 2.0, 3/07	Definite	Pesticides/ PCBs	GC-ECD	DESA Laboratory	N

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
C-93, C-94	Fluoride, Rev 1.0, 1/05, Anions by Ion Chromatography, Rev 2.0, 12/06	Definite	Fluoride	AutoAnalyzer, Ion Selective Electrode, IC	DESA Laboratory	N
C-95	Oil +Grease, Total Petroleum Hydrocarbon Gravimetric, SPE, Rev 2.0, 03/07	Definite	Oil +Grease	SPE apparatus	DESA Laboratory	N
C-96	Hexavalent Chromium, Rev 2.0, 3/07	Definite	Hexavalent Chromium	Spectrophotometer	DESA Laboratory	N
C-109	Determination of Trace Elements in Aqueous Trace Metals in Aqueous, Soil/Sediment/Sludge-ICP-AES, Rev 2.0, 3/07	Definite	TAL Metals	ICP-AES	DESA Laboratory	N
C-110	Mercury Analysis in Water and Soil/Sediments By CVAAS, Rev 2.0, 3/07	Definite	Mercury	CVAA	DESA Laboratory	N
C-112	Trace Metals in Aqueous, Soil/Sediment/Sludge, Waste Oil/Organic Solvent and Biological tissue by Inductively Coupled Plasma-Mass Spectrometry, Rev 2.0, 3/07	Definite	TAL Metals	ICP-MS	DESA Laboratory	N
C-115	Sulfide, Rev 1.0, 3/07	Definite	Sulfide	Spectrophotometer	DESA Laboratory	N

QAPP Worksheet #24

(UFP-QAPP Manual Section 3.2.2)

Identify all analytical instrumentation that requires calibration and provide the SOP reference number for each. In addition, document the frequency, acceptance criteria, and corrective action requirements on the worksheet.

Title:**Revision Number:****Revision Date:****Page ____ of ____****Analytical Instrument Calibration Table**

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference¹
ICP-AES	See SOP C-109	See SOP C-109	See SOP C-109	See SOP C-109	Assigned Laboratory personnel	SOP C-109
ICP-MS	See SOP C-112	See SOP C-112	See SOP C-112	See SOP C-112	Assigned Laboratory personnel	SOP C-112
CVAAS	See SOP C-110	See SOP C-110	See SOP C-110	See SOP C-110	Assigned Laboratory personnel	SOP C-110
IC	See SOP C-94	See SOP C-94	See SOP C-94	See SOP C-94	Assigned Laboratory personnel	SOP C-94
Spectrophotometer	See SOP C-96	See SOP C-96	See SOP C-96	See SOP C-96	Assigned Laboratory personnel	SOP C-96
Colorimetric/AutoAnalyzer	See SOP C-28 Per manufacture's manual	See SOP C-28	See SOP C-28	See SOP C-28	Assigned Laboratory personnel	SOP C-28
GC-ECD	See SOP C-91	See SOP C-91	See SOP C-91	See SOP C-91	Assigned Laboratory personnel	SOP C-91
GC-MS	See SOP C- 90, C-89	See SOP C- 90, C-89	See SOP C- 90, C-89	See SOP C- 90, C-89	Assigned Laboratory personnel	SOP C- 90, C-89
TOC Analyzer	See SOP C-88, Per manufacture's manual	See SOP C-88	See SOP C-88	See SOP C-88	Assigned Laboratory personnel	SOP C-88
pH Electrode	See SOP C-24	See SOP C-24	See SOP C-24	See SOP C-24	Assigned Laboratory personnel	SOP C-24

¹Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23). Details can be found in Equipment Calibration# SOP C-19

QAPP Worksheet #25

(UFP-QAPP Manual Section 3.2.3)

Identify all analytical instrumentation that requires maintenance, testing, or inspection and provide the SOP reference number for each. In addition, document the frequency, acceptance criteria, and corrective action requirements on the worksheet.

Title:

Revision Number:

Revision Date:

Page ____ of ____

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ¹
See list of Instrument given in Worksheet #24	See LQMP, G-10, G-11, G-12, G-19	See LQMP, G-10, G-11, G-12, G-19	See LQMP, G-10, G-11, G-12, G-19	See LQMP, G-10, G-11, G-12, G-19	See LQMP, G-10, G-11, G-12, G-19	See LQMP, G-10, G-11, G-12, G-19	See LQMP, G-10, G-11, G-12, G-19	See LQMP, G-10, G-11, G-12, G-19

¹Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

QAPP Worksheet #26

(UFP-QAPP Manual Appendix A)

Use this worksheet to identify components of the project-specific sample handling system. Record personnel, and their organizational affiliations, who are primarily responsible for ensuring proper handling, custody, and storage of field samples from the time of collection, to delivery, to final sample disposal. Indicate the number of days field samples and their extracts/digestates will be archived prior to disposal.

Sample Handling System**Title:****Revision Number:****Revision Date:****Page ____ of ____**

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization):
Sample Packaging (Personnel/Organization):
Coordination of Shipment (Personnel/Organization):
Type of Shipment/Carrier:
SAMPLE RECEIPT AND ANALYSIS (Details in SOP G-25)
Sample Receipt (Personnel/Organization): OSCAR/DESA Laboratory
Sample Custody and Storage (Personnel/Organization): OSCAR/DESA Laboratory
Sample Preparation (Personnel/Organization): Laboratory Personnel/DESA Laboratory
Sample Determinative Analysis (Personnel/Organization): Laboratory Personnel/DESA Laboratory
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection):
Sample Extract/Digestate Storage (No. of days from extraction/digestion): up to 60 days
Biological Sample Storage (No. of days from sample collection):
SAMPLE DISPOSAL (Details in SOP G-6)
Personnel/Organization: DESA Laboratory
Number of Days from Analysis: 60 days

QAPP Worksheet #27

(UFP-QAPP Manual Section 3.3.3)

Describe the procedures that will be used to maintain sample custody and integrity. Include examples of chain-of-custody forms, traffic reports, sample identification, custody seals, sample receipt forms, and sample transfer forms. Attach or reference applicable SOPs.

Title:

Revision Number:

Revision Date:

Page ____ of ____

Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to):

Sample Custody Procedures (receipt of samples, archiving, disposal):

See LQMP, SOP G-25(OSCAR)

Sample Identification Procedures:

See LQMP, SOP G-25(OSCAR)

Chain-of-custody Procedures:

See LQMP, SOP G-25(OSCAR)

QAPP Worksheet #28 (Semi volatiles)

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limits exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Title:**Revision Number:****Revision Date:****Page ____ of ____****QC Samples Table**

Matrix	Aqueous/ Soil					
Analytical Group	SVOC					
Concentration Level						
Sampling SOP						
Analytical Method/ SOP Reference	C-90 (Ref: EPA 625)					
Sampler's Name						
Field Sampling Organization						
Analytical Organization	USEPA Region 2 Laboratory					
No. of Sample Locations						
QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Tuning	12 hr period	Pass all DFTPP tune criteria	Check Instrument Reanalyze, Retune	Laboratory personnel	Sensitivity	Pass all DFTPP tune criteria
Initial Calibration	SOP C-90	% RSD +/- 35% Allowed to fail 10% of total number of analytes but % RSD not be more than 60%	Check Instrument, Reanalyze	Laboratory personnel	Accuracy/ Precision	% RSD +/- 35% Allowed to fail 10% of total number of analytes but % RSD not be more than 60%

Continuing Calibration Check Standard (Alternate check standard)	1 per analytical batch of ≤ 20 samples	Min RRF 0.05 Max %D +/- 20% 10% of total analytes allowed to fail but not more than 60%	Reanalyze, Qualify data	Laboratory personnel	Accuracy	Min RRF 0.05 Max %D RRF +/- 20% 10% of total analytes allowed to fail but not more than 60%
Method Blank	1 per extraction batch of ≤ 20 samples	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL
LCS/LFB	2 per extraction batch of ≤ 20 samples	Limits listed in Table3 in SOP C-90 for aqueous, manufacture's limits for soil % RPD < 30	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy/ Precision	Limits listed in Table3 in SOP C-90 for aqueous, manufacture's limits for soil % RPD < 30
Matrix spikes	1 per extraction batch of ≤ 20 samples	Limits listed in Table3 in SOP C-90	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy	Limits listed in Table3 in SOP C-90
Internal Standards	Each sample, standard, blank	Factor of two (-50% to -100%)	Check Instrument Analyse / Qualify data	Laboratory personnel	Quantitation	Factor of two (-50% to -100%)
Surrogates	Each sample, standard, blank	30%-120% for Base Neutrals 20-120% for Acids	Reinject, Qualify data as per SOP C-90	Laboratory personnel	Extraction efficiency, Accuracy	30%-120% for Base Neutrals 20-120% for Acids

QAPP Worksheet #28 (Metal+ Mercury)

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limits exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Title:**Revision Number:****Revision Date:****Page ____ of ____****QC Samples Table**

Matrix	Aqueous/Soil
Analytical Group	Metals & Mercury
Concentration Level	Trace/Low
Sampling SOP	
Analytical Method/ SOP Reference	C-109,C-112, C-110 (Ref: EPA 200.7, 200.8, 245.1)
Sampler's Name	
Field Sampling Organization	
Analytical Organization	USEPA Region 2 Laboratory
No. of Sample Locations	

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Tuning/System Stability(ICP-MS)	As per C-112	Pass all the tune/stability criteria	Check Instrument Reanalyze, Retune	Laboratory personnel	Sensitivity	Pass all the tune/stability criteria
Initial Calibration Verification	Immediately following each calibration ,after every 10 samples and at the end of each analytical run	90%-110%	Check Instrument, Reanalyze	Laboratory personnel	Accuracy	90%-110%

Continuing Calibration Check Standard (Alternate check standard)	Every 10 samples and at the end of each analytical run	80%-120%	Reanalyze, Qualify data	Laboratory personnel	Accuracy	80%-120%
Initial Calibration Blank(ICB)	After ICV	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL
Continuing Calibration Blank(CCB)	After every CCV	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL
Low Level Check Standard	At Beginning and end of each analytical run	± 30% of the true value	Check Instrument, Re-calibrate	Laboratory personnel	Accuracy	± 30% of the true value
Interference Check Sample(ICP-200.7)	At Beginning and end of each analytical run	< RL Except Al ,Fe, Ca, K, Mg and Na	As per C-109	Laboratory personnel	Precision	< RL Except Al ,Fe, Ca, K, Mg and Na
Method blank	1 per extraction batch of ≤ 20 samples	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL
LCS/LFB	2 per extraction batch of ≤ 20 samples	Limits: Average Recovery ± 20% aqueous, ± 25% Soil) % RPD < 20(Aq), % RPD <25(Soil)	Qualify data	Laboratory personnel	Accuracy/ Precision	Limits: Average Recovery ± 20% aqueous, ± 25% Solids) % RPD < 20(Aq), % RPD <25(Soil)
Matrix spikes	1 per extraction batch of ≤ 20 samples	Limits ± 20% aqueous, ± 25% Soil)	Qualify data	Laboratory personnel	Accuracy	Limits ± 20% aqueous, ± 25% Soil)
Serial Dilution Test(ICP-200.7)	Matrix spike sample	RPD < 20 %	Qualify data	Laboratory personnel	Precision	RPD < 20 %
Internal Standards(ICP-MS 200.8)	Each sample, standard, blank	Range of 0.60-1.87 of the original response in the calibration blank	Check Instrument Analyse / Qualify data	Laboratory personnel	Quantitation	Range of 0.60-1.87 of the original response in the calibration blank

QAPP Worksheet #28 (Microbiology)
(UFP-QAPP Manual Section 3.4)

Title:
Revision Number:
Revision Date:
Page ____ of ____

QC Samples Table

Matrix	Aqueous/Soilds					
Analytical Group	Microbiology					
Concentration Level	N/A					
Sampling SOP						
Analytical Method/ SOP Reference	See notes					
Sampler's Name						
Field Sampling Organization						
Analytical Organization	USEPA Region 2 Laboratory					
No. of Sample Locations						
QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Sterility or Performance Testing	Each lot of pre-prepared, ready to use medium or batch of medium prepared in the Laboratory, sample containers on a non-selective media	No growth	Investigate source of contamination Prepared Media is discarded	Laboratory personnel	Media selectivity, sensitivity Contamination	No growth
Method Blank	1 per preparation batch of 20 samples	No growth	Investigate source of contamination	Laboratory personnel	Contamination	No growth
Control Sample (LCS)-positive control	1 per preparation batch of 20 samples	Growth promotion	Reanalyzed	Laboratory personnel	Media selectivity, sensitivity	Growth promotion
Duplicate counts (Membrane Filtration or Heterotrophic Plate count)	Monthly on one positive sample for each month the test is performed	10% (different analyst) 5% (same analyst)	Qualify data	Laboratory personnel	Precision	10% (different analyst) 5% (same analyst)

Laboratory SOPs: B-5/B-7(*SM 9222B/D*); B-6/B-8(*SM 9221B/E*) , B-32; (Ref: *EPA 9215B*); B-38(Ref: *Simplate IDEX*)

QAPP Worksheet #28 (Pesticides/PCBs)

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limits exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Title:
Revision Number:
Revision Date:
Page ____ of ____

QC Samples Table

Matrix	Aqueous/Soil					
Analytical Group	Pesticides/PCBs					
Concentration Level						
Sampling SOP						
Analytical Method/ SOP Reference	C-91 (Ref: EPA 608)					
Sampler's Name						
Field Sampling Organization						
Analytical Organization	USEPA Region 2 Laboratory					
No. of Sample Locations						
QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Instrument Performance (PEM)	Beginning of each analytical run	Total breakdown <30%	Check Instrument	Laboratory personnel	Sensitivity Contamination	Total breakdown <30%
Initial Calibration	C-91 (Ref: EPA 608)	% RSD +/- 25% Not more than 10% of total analytes failure RSD not more than 30%	Check Instrument, Reanalyze	Laboratory personnel	Accuracy/ Precision	% RSD +/- 25% Not more than 10% of total analytes failure RSD not more than 30%
Continuing Calibration Check Standard (Alternate check standard)	Beginning and the end of each analytical run	Max %D RRF +/- 25%	Reanalyze, Qualify data	Laboratory personnel	Accuracy	Max %D RRF +/- 25%
Method Blank	1 per extraction batch	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL

LCS/LFB	2 per extraction batch	Limits: Average Recovery 50-150% % RPD < 30	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy/ Precision	Limits: Average Recovery 50-150% % RPD < 30
Matrix spikes	1 per extraction batch	Limits 30-150%	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy	Limits 30-150%
Surrogates	Each sample, standard, blank	Limits 30%-150%	Reinject, Qualify data	Laboratory personnel	Extraction efficiency, Accuracy	Limits 30%-150%

QAPP Worksheet #28 (Sanitary Chemistry)

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limits exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Title:**Revision Number:****Revision Date:****Page ____ of ____****QC Samples Table**

Matrix	Aqueous/Soil
Analytical Group	Sanitary Chemistry
Concentration Level	Low/Medium
Sampling SOP	
Analytical Method/ SOP Ref	See notes below
Sampler's Name	
Field Sampling Organization	
Analytical Organization	USEPA Region 2 Laboratory
No. of Sample Locations	

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator (DQI)	Measurement Performance Criteria
Initial Calibration Verification (ICV)	Immediately after initial calibration	90%-110% of the true value except for TOC ($\pm 15\%$)	Recalibrate	Corrective Action by Laboratory personnel	Accuracy/ Precision	90%-110% of the true value
Initial calibration Blank(ICB)	Immediately after ICV	< RL	Investigate source of contamination		Sensitivity Contamination	< RL
Continuing Calibration Verification (CCV) (Alternate check standard)	After every ten samples and at the end of the analytical run.	90%-110% of the true value	Reanalyze, Qualify data		Accuracy	90%-110% of the true value
Continuing Calibration Blank (CCB)		< RL	Investigate source of contamination		Sensitivity Contamination	< RL
Method Blank	1 per extraction /analytical batch					
Laboratory Control Sample (LCS/LFB)	2 per extraction batch of ≤ 20 samples	Limits: Average Recovery meet standard manufacturer's limits; % RPD < 20	Reanalyze, Qualify data		Accuracy/ Precision	Limits: Average Recovery meet standard manufacturer's limits; % RPD < 20
Matrix spike (MS)	1 per extraction batch of ≤ 20 samples	Limits 80-120%	Qualify data		Accuracy	Limits 80-120%

Laboratory SOPs: C-28,C-29,C-40, C-53,C-68,C-79, C-80,C-83, C-88, C-94,C-96 (Ref: EPA 335.4, 420.4, 351.2, 410.4, 365.1, 353.2, 350.1, SM 5310 B, EPA 300.0, I-1230-85)

QAPP Worksheet #28 (Sanitary Chemistry)
(UFP-QAPP Manual Section 3.4)

Title:
Revision Number:
Revision Date:
Page ____ of ____

QC Samples Table

Matrix	Aqueous/Soil					
Analytical Group	Sanitary Chemistry					
Concentration Level						
Sampling SOP						
Analytical Method/ SOP Reference	See notes below					
Sampler's Name						
Field Sampling Organization						
Analytical Organization	USEPA Region 2 Laboratory					
No. of Sample Locations						
QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per analytical batch of 20 samples	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL
Control Sample (LCS/LFB)	2 per analytical batch of 20 samples	Limits: Average Recovery within the standard manufacture's limits or method limits; % RPD < 20	Reanalyzed or Qualify data	Laboratory personnel	Accuracy/Precision	Limits: Average Recovery within the standard manufacture's limits % RPD < 20
Sample Duplicates - TSS,TDS, Specific Conductance, Turbidity, pH, Ignitability	1 per analytical batch of 20 samples	% RPD < 20	Affected sample Qualified	Laboratory personnel	Precision	% RPD < 20
Matrix spike (MS) - Alkalinity, Sulfate, Chloride, BOD/ cBOD	1 per extraction batch of 20 samples	Limits 80-120%	Affected sample Qualified	Laboratory personnel	Accuracy	Limits 80-120%

Laboratory SOPs: C-18,C-19,C-21, C-22, C-23, C-24, C-33, C-36, C-37, C-81

(Ref: SM 2320 B, ASTM D516-02, SM 5210 B, SM4500CI-C, SW 846 1010, SM 4500-H+ B, SM 2540 D, EPA 120.1, SM 2540 C, EPA 180.1)

QAPP Worksheet #28 (Volatiles-Low)

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limits exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Title:**Revision Number:****Revision Date:****Page ____ of ____****QC Samples Table**

Matrix	Aqueous/Soil
Analytical Group	VOC
Concentration Level	Low(Aq)/Medium (soil
Sampling SOP	
Analytical Method/ SOP Reference	C-89 (Ref: EPA 624)
Sampler's Name	
Field Sampling Organization:	
Analytical Organization	USEPA Region 2 Laboratory
No. of Sample Locations	

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible	Data Quality Indicator (DQI)	Measurement Performance Criteria
Tuning	12 hr period	Pass all PBFB tune criteria	Check Instrument Reanalyze, Retune	Corrective Action by Laboratory personnel	Sensitivity	Pass all PBFB tune criteria
Initial Calibration	SOP C-89	% RSD +/- 35% Not more than 10% of total analytes failure % RSD not more than 60%	Check Instrument, Reanalyze		Accuracy/ Precision	% RSD +/- 35% Not more than 10% of total analytes failure % RSD not more than 60%
Continuing Calibration Check Standard (Alternate check standard)	1 per analytical batch of 20 samples	Max %D RRF +/- 30% Not more than 10% of total analytes failure % D not more than 60%	Reanalyze, Qualify data	Laboratory personnel	Accuracy	Max %D RRF +/- 30% Not more than 10% of total analytes failure % D not more than 60%
Method Blank	1 per extraction batch of 20 samples	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL
Trip Blank	1 per cooler containing VOC samples	Client Defined	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	

LCS/LFB	2 per extraction batch of 20 samples	Limits: Average Recovery 70-130% % RPD < 20	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy/ Precision	Limits: Average Recovery 70-130% % RPD < 20
Matrix spikes	1 per extraction batch of 20 samples	Table 4 of C-89 compound specific (full range- 17-259%)	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy	Table 4 of C-89 compound specific (full range- 17-259%)
Internal Standards	Each sample, standard, blank	Factor of two(-50% to + 100%) from the initial/continuing calibration	Check Instrument Analyse / Qualify data	Laboratory personnel	Quantitation	Factor of two(-50% to + 100%) from the initial/continuing calibration
Surrogates	Each sample, standard, blank	Limits 70%-130%	Reinject, Qualify data	Laboratory personnel	Extraction efficiency, Accuracy	Limits 70%-130%

QAPP Worksheet #28 (Volatiles-Low)

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limits exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Title:**Revision Number:****Revision Date:****Page ____ of ____****QC Samples Table**

Matrix	Soil
Analytical Group	VOC
Concentration Level	Low
Sampling SOP	
Analytical Method/ SOP Reference	C-123 (Ref: EPA 624)
Sampler's Name	
Field Sampling Organization	
Analytical Organization	USEPA Region 2 Laboratory
No. of Sample Locations	

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Tuning	12 hr period	Pass all PBFB tune criteria	Check Instrument Reanalyze, Retune	Laboratory personnel	Sensitivity	Pass all PBFB tune criteria
Initial Calibration	SOP C-123	% RSD +/- 50% Min RRF 0.010	Check Instrument, Reanalyze	Laboratory personnel	Accuracy/ Precision	% RSD +/- 50% Min RRF 0.010
Continuing Calibration Check Standard (Alternate check standard)	1 per analytical batch of 20 samples	Max %D listed in Table 4A of C-123	Reanalyze, Qualify data	Laboratory personnel	Accuracy	Max %D listed in Table 4A of C-123
Method Blank	1 per extraction batch of 20 samples	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL

Trip Blank	1 per cooler containing VOC samples	Client Defined	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	
LCS/LFB	2 per extraction batch of 20 samples	Limits: Average Recovery 70-130% % RPD < 20	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy/ Precision	Limits: Average Recovery 70-130% % RPD < 20
Matrix spikes	1 per extraction batch of 20 samples	Table 8 of C-123 compound specific (full range- 17-259%)	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy	Table 8 of C-123 compound specific (full range- 17-259%)
Internal Standards	Each sample, standard, blank	Factor of two(-50% to + 100%) from the initial/continuing calibration	Check Instrument Analyse / Qualify data	Laboratory personnel	Quantitation	Factor of two(-50% to + 100%) from the initial/continuing calibration
Surrogates	Each sample, standard, blank	Table 7 of C-123	Reinject, Qualify data	Laboratory personnel	Extraction efficiency, Accuracy	Table 7 of C-123

QAPP Worksheet #28 (Volatiles- Trace)

(UFP-QAPP Manual Section 3.4)

Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, analytical group, and concentration level. If method/SOP QC acceptance limits exceed the measurement performance criteria, the data obtained may be unusable for making project decisions.

Title:**Revision Number:****Revision Date:****Page ____ of ____****QC Samples Table**

Matrix	Aqueous					
Analytical Group	VOC					
Concentration Level	Trace					
Sampling SOP						
Analytical Method/ SOP Reference	DW-1 (Ref: EPA 524.2)					
Sampler's Name						
Field Sampling Organization						
Analytical Organization	USEPA Region 2 Laboratory					
No. of Sample Locations						
QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Tuning	12 hr period	Pass all PBFB tune criteria	Check Instrument Reanalyze, Retune	Laboratory personnel	Sensitivity	Pass all PBFB tune criteria
Initial Calibration	SOP DW-1	% RSD +/- 20% Not more than 10% of total analytes failure	Check Instrument, Reanalyze	Laboratory personnel	Accuracy/ Precision	% RSD +/- 20% Not more than 10% of total analytes failure
Continuing Calibration Check Standard (Alternate check standard)	1 per analytical batch	Max %D RRF +/- 30% Not more than 10% of total analytes failure	Reanalyze, Qualify data	Laboratory personnel	Accuracy	Max %D RRF +/- 30% Not more than 10% of total analytes failure

Method Blank	1 per extraction batch	< RL	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	< RL
Trip Blank	1 per cooler containing VOC samples	Client Defined	Investigate source of contamination	Laboratory personnel	Sensitivity Contamination	
LCS/LFB	2 per extraction batch	Limits: Average Recovery 70-130% % RPD < 20	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy/ Precision	Limits: Average Recovery 70-130% RPD 20%
Matrix spikes	1 per extraction batch	Limits 70-130%	Qualify data unless high recovery and/or Not Detected)	Laboratory personnel	Accuracy	Limits 70-130%
Internal Standards	Each sample, standard, blank	+/- 40% from the initial/continuing calibration	Check Instrument Analyse / Qualify data	Laboratory personnel	Quantitation	+/- 40% from the initial/continuing calibration
Surrogates	Each sample, standard, blank	Limits 80%-120%	Reinject, Qualify data	Laboratory personnel	Extraction efficiency, Accuracy	Limits 80%-120%

QAPP Worksheet #29

(UFP-QAPP Manual Section 3.5.1)

Identify the documents and records that will be generated for all aspects of the project including, but not limited to, sample collection and field measurement, on-site and off-site analysis, and data assessment.

Title:**Revision Number:****Revision Date:****Page ____ of ____****Project Documents and Records Table**

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Field Chains-of-Custody	Internal Chains-of-Custody		Sample acceptance checklist	Customer Service Survey Cards
Packing Slips and Sample Tags	Sample Preparation Log		PT Sample Results	Telephone Logs
Request Forms and Associated Correspondence	Standard Traceability Record		Training Records	Procurement Request Forms
Sample Acceptance Checklist	Instrument Analysis Log			
	QC summary checklist with all relevant information		MDL Study Records	Equipment Maintenance Logs
LIMS Sample Receipts	Sample Analysis Data		Initial DOC / CDOC Records	Validated Computer Software Records
Automated OSCAR Logs	Instrument Calibration Data		Internal Audit Reports	
sample identification numbers	Instrument/ Computer Printouts		Corrective Action Reports	
	Definition of Qualifiers		External Assessment	
	Cover Letter			
	Approval Form		NELAC Accreditation	
	Case Narrative			
	Final Report			

QAPP Worksheet #31

(UFP-QAPP Manual Section 4.1.1)

Identify the type, frequency, and responsible parties of planned assessment activities that will be performed for the project.

Title:**Revision Number:****Revision Date:****Page ____ of ____****Planned Project Assessments Table**

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
PT	Semiannually	External	NELAC	PT provider	Laboratory Personnel	Laboratory Personnel	Laboratory QA Officer
NELAC	Every two years	External	NELAC	Florida DOH	Laboratory QA Officer	Laboratory Personnel	Florida DOH
INTERNAL AUDIT	Monthly	Internally	DESA Laboratory	Laboratory QA Officer	Laboratory Personnel	Laboratory Personnel	Laboratory QA Officer

QAPP Worksheet #32

(UFP-QAPP Manual Section 4.1.2)

For each type of assessment describe procedures for handling QAPP and project deviations encountered during the planned project assessments.

Title:

Revision Number:

Revision Date:

Page ____ of ____

Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Proficiency Testing (PT)	Letter with PT failure indicated	Laboratory QA Officer	30 days after the audit	Investigate the reason for the PT failure	Laboratory QA Officer	45 days after the CA report
NELAC	Audit Report with Non-conformance to QAPP, SOPs, NELAC+LQMP	Laboratory Management	30 days after the audit	Investigate and have a corrective action plan for the deficiencies	Florida DOH	30 days after receiving notification
INTERNAL	Audit Report with Non-conformance to QAPP, SOPs, NELAC Regulations	Laboratory Management	30 days after the audit	Investigate and have a corrective action plan for the deficiencies	Laboratory QA Officer	45 days after the CA report

QAPP Worksheet #34

(UFP-QAPP Manual Section 5.2.1)

Describe the processes that will be followed to verify project data.

Manual (Section 5.1). Describe how each item will be verified, when

the activity will occur, and what documentation is necessary, and identify

the person responsible. *Internal* or *external* is in relation to the data generator.**Title:****Revision Number:****Revision Date:****Page ____ of ____****Verification (Step I) Process Table**

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Chain of Custody	Chain-of-custody forms will be verified against the sample cooler they represent. Sample Acceptance Checklist is completed. The OSCAR staff supervisor utilizes the analyses request information and the external COC to review the accuracy and completeness of LIMS log-in entries, as reflected on the LIMS Sample Receipt Form Details can be found in Quality Management Plan, SOP G-25	Internal	OSCAR Personnel DESA Laboratory
Analytical data package/ Final Report	The procedures for data review : 1- Data reduction/review by Primary Analyst. 2- Review complete data package (raw data) by independent Peer Reviewer 3- The Sample Project Coordinator reviews the project documentation for completeness followed by a QA review by the QAO 4- Final review by Branch Chief/Section Chief prior to release, this review is to ensure completeness and general compliance with the objectives of the project. This final review typically does not include a review of raw data. Details can be found in the Quality Management Plan.	Internal	Primary Analyst, Peer Reviewer, Sample Project Coordinator, Quality Assurance Officer, Section Chief/ Branch Chief. DESA Laboratory

QAPP Worksheet #35

UFP-QAPP Manual Section 5.2.2

Describe the processes that will be followed to validate project data.

Validation inputs include items such as those listed in Table 9

of the UFP-QAPP Manual (Section 5.1). Describe how each item will be

validated, when the activity will occur, and what documentation is necessary and

identify the person responsible. Differentiate between steps IIa and IIb of validation.

Revision Number:

Revision Date:

Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
	Chain of Custody	Chain-of-custody forms will be verified against the sample cooler they represent. Sample Acceptance Checklist is completed. The OSCAR staff supervisor utilizes the analyses request information and the external COC to review the accuracy and completeness of LIMS log-in entries, as reflected on the LIMS Sample Receipt Form Details can be found in Quality Management Plan, SOP G-25	OSCAR Personnel DESA Laboratory
	Analytical data package/ Final Report	The procedures for data review : 1- Data reduction/review by Primary Analyst. 2- Review complete data package (raw data) by independent Peer Reviewer 3- The Sample Project Coordinator reviews the project documentation for completeness followed by a QA review by the QAO 4- Final review by Branch Chief/Section Chief prior to release, this review is to ensure completeness and general compliance with the objectives of the project. This final review typically does not include a review of raw data. Details can be found in the Quality Management Plan.	Primary Analyst, Peer Reviewer, Sample Project Coordinator, Quality Assurance Officer, Section Chief/ Branch Chief. DESA Laboratory

* DESA performs the validation.